APPENDIX E

E. National Vegetation Classification (NVC) Local and Global Descriptions for Walnut Canyon National Monument

(Kathryn Thomas and Monica Hansen of the USGS Colorado Plateau Research Station collected, analyzed, and initially classified field relevé data. Marion Reid and Keith Schulz of NatureServe reviewed and finalized the local classification and compiled the global classification.)

The following vegetation descriptions are derived from the 109 vegetation relevés sampled throughout the course of this project. Global information, information based on reports throughout the distribution of the associations/alliances, was also compiled by NatureServe to augment the local descriptions. All of the vegetation association descriptions will include information on both the global and local descriptions, unless the associations have only been described from Walnut Canyon National Monument.

Each description is separated into twelve sections. Many of the sections are subdivided into a 'Walnut Canyon National Monument' or 'Globally' subsection. After the Walnut Canyon National Monument subheading, information follows on the association/alliance as it appears in the park, the local information. After the Globally subheading information follows on the association/alliance as it appears throughout its range. Information about each of the sections is described in Table 1. References for all the vegetation descriptions are combined at the end of Appendix E.

Table 1. Explanations on the vegetation descriptions sections.

Vegetation Description Sections	**Explanation**
Classification Confidence Level	The classification confidence level identified by NatureServe.
USFS Wetland System	The U.S. Dept. of Agriculture – Forest Service wetland classification system ranking crosswalked to NVCS associations, provided by NatureServe.
Range	The range describes where this association was mapped in the project area, information on where particular relevés were sampled, and where the association occurs throughout its entire range.
Environmental Description	Environmental description describes the abiotic conditions measured for the association/alliance. In the local descriptions, all slopes are described as a range of elevation (lowest to highest elevation) as well as an average elevation across all of the relevés measured in feet (ft) and meters (m).
Most Abundant Species	This section identifies the dominant and/or indicator species for Walnut Canyon National Monument and globally throughout its range.
Associated Species	Associated species describes the most common species associated with all of the relevés locally and globally.
Vegetation Description	This section identifies the vegetation characteristics specific to the association/alliance. Locally, total vegetation cover is described as absolute percent cover and is given as a range (lowest to highest % cover) and average across all of the relevés. Diameter Base Height (DBH) is provided in inches (in) and centimeters (cm) if trees were present in the relevés.
Conservation Rank	The conservation rank is a ranking system used to identify and prioritize conservation areas applied to NVCS associations by

	NatureServe. The global conservation rank is described in the Table 2. See NatureServe Explorer for further documentation of NaturServe's ranking system (http://www.natureserve.org/explorer/).
Database Code	Database codes are a unique code that NatureServe developed to organize and identify the vegetation associations.
Map Classes	Map classes describes how the association is crosswalked to the map class, a general description of where the map class occurs, and the total number of acres (ac)/hectares (ha) and polygons occurring inside and outside Walnut Canyon National Monument.
Comments	Comments particular to the vegetation description locally at Walnut Canyon National Monument and globally.
Dynamics	Information on the global vegetation dynamics.

Table 2. Conservation ranking system for associations.

Global Conservation Rank
GX – Eliminated
GH – Presumed eliminated (historic)
G1 – Critically imperiled
G2 – Imperiled
G3 – Vulnerable
G4 – Apparently secure
G5 – Secure
GU – Unrankable
G? – Unranked

List of vegetation community types (NVCS Associations) organized by NVCS structure:

Pseudotsuga menziesii / Quercus gambelii Forest

MAP CLASS	Douglas-fir / Gambel Oak Forest, Canyon Floor Complex
COMMON NAME	Douglas-fir / Gambel Oak Forest
PHYSIOGNOMIC CLASS	Forest (I.)
PHYSIOGNOMIC SUBCLASS	Evergreen forest (I.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen forest (I.A.8.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (I.A.8.N.)
FORMATION	Conical-crowned temperate or subpolar needle-leaved evergreen forest (I.A.8.N.c.)
ALLIANCE	*Pseudotsuga menziesii* Forest

CLASSIFICATION CONFIDENCE LEVEL Moderate

USFS WETLAND SYSTEM Upland

RANGE

Walnut Canyon National Monument

Douglas-fir / Gambel Oak Forest is a common association within the more mesic habitats at Walnut Canyon NM and its environs. This association was only found in side drainages at higher elevations and cooler north and east facing slopes of the southwestern section of the project boundary on Walnut Canyon NM and the Forest Service lands.

Globally

This *Pseudotsuga menziesii* forest association occurs in the southern Rocky Mountains and southwestern U.S. and is found on foothills, mountains and plateaus from Colorado to Trans-Pecos Texas, west to Arizona and Utah.

ENVIRONMENTAL DESCRIPTION

Walnut Canyon National Monument

This association occurs mainly on higher elevation sites from 1980-2130m (average 2,050m). All of the relevés occurred within side drainages on steep or gradual slopes ranging from 15-65% slope (average 50%) and with northern or eastern exposures.

Globally

This forest association occurs on mountains and plateaus from Colorado to Trans-Pecos Texas, west to Arizona and Utah. Elevation ranges from 1370-2870 m (4500-9400 ft). Stands are found along drainages, gentle to moderate lower and middle slopes, steep upper slopes and ridgetops. Aspects are variable. This forest occurs as both a non-obligate riparian community on the outer margins of riparian areas in desert canyons and steep draws, and as an upland forest forming extensive stands on typically north-facing hillslopes (southern aspects at higher elevations). Soils vary, but are often shallow and rocky, ranging from sandy loams to clay. The surface is generally largely covered with a thin layer of litter. Parent materials include fractured limestone, sandstone, basalt and andesite.

MOST ABUNDANT SPECIES

Walnut Canyon National Monument

Stratum	Species
Tree canopy	*Pseudotsuga menziesii*
Tall Shrub	*Quercus gambelii*

Globally

Stratum	Species
Tree canopy	*Pseudotsuga menziesii, Pinus ponderosa, Pinus strobiformis,*
Tall Shrub	*Quercus gambelii*

ASSOCIATED SPECIES
Walnut Canyon National Monument
Juniperus scopulorum, Pinus ponderosa (all occur with >5% cover)

Globally
Acer glabrum, Achillea millefolium, Amelanchier spp., *Arctostaphylos patula, Bromus* spp., *Carex rossii, Cercocarpus montanus, Festuca arizonica, Holodiscus dumosus, Juniperus deppeana, Juniperus osteosperma, Koeleria macrantha,Lathyrus lanszwertii* var. *leucanthus, Mahonia repens, Muhlenbergia montana, Muhlenbergia virescens, Paxistima myrsinites, Pinus edulis, Pinus ponderosa, Pinus strobiformis, Poa fendleriana, Prunus virginiana, Ribes cereum, Robinia neomexicana, Rosa woodsii, Symphoricarpos oreophilus, Thalictrum fendleri, Vicia americana*

VEGETATION DESCRIPTION
Walnut Canyon National Monument
Douglas-fir / Gambel Oak Forest total vegetation cover ranged from 41-75% (average 59%) with 28-62% absolute cover (average 45%) in the tree layer, 6-20% (average 10%) in the shrub layer, and 4-15% (average 9%) in the herbaceous layer. The total species diversity ranged from 12-30 species (average 23) within the 7 relevés sampled.

The tree layer was dominated by *Pseudotsuga menziesii* with 16-62% absolute cover (average 29%) with DBH ranging from 4-26 in (11-67 cm) (average 8 in/21 cm). *Juniperus scopulorum* and *Pinus ponderosa* may co-dominate or have high cover within this association; however, they never dominate the tree canopy. The shrub layer consistently was dominated by *Quercus gambelii* with 4-22% absolute cover (average 16%); however, it occurred within the ground and tree layer as well. DBH for the larger tree layer ranged from 4-12 in (11-31 cm) (average 6 in/16 cm). The herbaceous layer contained a variety of herbs and grasses including *Artemisia ludoviciana, Bromus ciliatus, Poa fendleriana, Ptelea trifoliata, Thalictrum fendleri, Valeriana arizonica,* and *Vicia americana.*

Globally
This association is characterized by a relatively sparse to moderately dense evergreen tree canopy dominated by *Pseudotsuga menziesii* sometimes with scattered large *Pinus ponderosa, Pinus strobiformis, Pinus edulis,* or *Juniperus* spp. (especially on drier sites). *Abies concolor* is typically not present. *Quercus gambelii* dominates both the subcanopy (tree form, if present) and the moderately dense tall-shrub layer that consists of dense clumps of oak. *Quercus gambelii* must have at least 5% cover, but there is frequently over 25%. At higher elevations, the *Quercus gambelii* are more tree-like and *Symphoricarpos oreophilus* will be present with significant cover in the short-shrub layer. At lower elevations, scattered *Pinus edulis, Juniperus osteosperma,* or *Juniperus deppeana* are often present. Other common shrub species depending on range may include *Acer glabrum, Arctostaphylos patula, Amelanchier* spp., *Cercocarpus montanus, Holodiscus dumosus, Mahonia repens, Paxistima myrsinites, Prunus virginiana, Ribes cereum, Robinia neomexicana,* and *Rosa woodsii*. The generally sparse herbaceous layer is composed of mostly graminoids with scattered forbs, but ranges to moderately dense and diverse. Associated graminoids may include *Bromus* spp., *Carex rossii, Festuca arizonica, Koeleria macrantha, Muhlenbergia montana, Muhlenbergia virescens,* and *Poa fendleriana*. Common forbs include *Achillea millefolium, Lathyrus lanszwertii* var. *leucanthus, Thalictrum fendleri,* and *Vicia americana*. The shrub layer has equal or greater cover than graminoids. This open conifer forest transitions to *Quercus gambelii* woodlands in drier sites and at lower elevations.

CONSERVATION RANK G5

DATABASE CODE CEGL000452

MAP CLASSES
The association Douglas-fir / Gambel Oak Forest is represented by map classes Douglas-fir / Gambel Oak Forest (map code 16) and Canyon Floor Complex (map code 10).

This association has a broad distribution within two map classes: one occurring in more mesic habitat, Canyon Floor Complex, and one occurring in cooler rim and side drainage habitats, Douglas-fir / Gambel Oak Forest. The distinguishing feature between the Douglas-fir / Gambel Oak Forest and the Canyon Floor Complex is that the Canyon Floor Complex occurs within the more mesic Walnut Creek canyon bottom. The total area of Douglas-fir / Gambel Oak Forest within Walnut Canyon NM is 320 ac (129 ha) within 29 polygons and the total area in the park

environs is 120 ac (48 ha) within 13 polygons. The total area of Canyon Floor Complex within Walnut Canyon NM is 120 ac (48 ha) within 39 polygons and the total area in the park environs is 32 ac (13 ha) within 23 polygons.

COMMENTS

Walnut Canyon National Monument

Due to Walnut Canyon and the adjacent side canyons often having a narrow canyon bottom, it was difficult to distinguish unique occurrences of this association within the Canyon Floor Complex. Therefore, this association was mapped as part of the Canyon Floor Complex map class, when it occurred within the riparian areas.

Globally

Within the habitat type literature there are four phases mentioned: *Festuca arizonica* phase, *Holodiscus dumosus* phase, *Muhlenbergia virescens* phase (all defined by having at least 5% cover of both *Quercus gambelii* and the nominal species), and *Quercus gambelii* (typic) phase by a undeveloped herbaceous layer (Alexander et al. 1984, Alexander et al. 1987, DeVelice et al. 1986, Fitzhugh et al. 1987, Johnston 1987, Larson and Moir 1987, Muldavin et al. 1996, Stuever and Hayden 1997b). There are 3 similar NVCS *Pseudotsuga menziesii* associations that use these phase species as the nominal species. These phases represent "intermediate" vegetation. Review of these associations is needed to clarify relationships between associations.

DYNAMICS

Globally

This association represents mid- to late-seral forests that are dominated by *Pseudotsuga menziesii* with the diagnostic *Quercus gambelii*-dominated understory. Large, often fire-scarred *Pinus ponderosa* trees may be present to codominant in the canopy, but do not reproduce (Alexander et al. 1984, DeVelice et al. 1986).

REFERENCES

Alexander et. al. 1984, Alexander et. al. 1987, Bader 1932, Blackhawk Coal Company 1981, Bourgeron et. al. 1993, Bourgeron et. al. 1995, Bourgeron and Engelking 1994, Devalice et. al. 1986, Diamond 1993, Fitzhugh et. al. 1987, Freeman and Dick-Peddie 1970, Hess and Wesser 1982, Johnston 1987, Keammerer 1974, Kittel et. al. 1994, Kittel et. al. 1999a, Kittel et. al. 1999b, Kamarakova et. al. 1988a, Kamarakova et. al. 1988b, Larsen and Moir 1987, Muldavin et. al. 1996, Stuever and Hayden 1997b, Tiedeman and Terwilliger 1997b, Western Ecology Working Group of Nature Serve, Youngblood and Mauk 1985

Note:

This association is found in two different map classes:

1) Canyon Floor Complex
2) Douglas-fir / Gambel Oak Forest

Juniperus osteosperma Woodland Alliance

MAP CLASS	Pinyon Pine – Utah Juniper / Blue Grama Woodland
COMMON NAME	Utah Juniper Woodland Alliance
PHYSIOGNOMIC CLASS	Woodland (II.)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*Juniperus osteosperma* Woodland Alliance

CLASSIFICATION CONFIDENCE LEVEL Alliances are not ranked by NatureServe for classification confidence

USFS WETLAND SYSTEM Upland

RANGE

Walnut Canyon National Monument

Utah Juniper Woodland Alliance was only identified from one relevé within Forest Service lands on Anderson Mesa.

Globally

These woodlands are distributed across the Great Basin and Colorado Plateau from the central Rocky Mountains of central Wyoming and western Colorado, through southern Idaho, Utah, and Nevada to the northern Mojave region of California. A second substantial range occurs along interior slopes the transverse ranges of southern California.

ENVIRONMENTAL DESCRIPTION

Walnut Canyon National Monument

Only one relevé was assigned to this alliance; it occurred in a flat area with an elevation of 6,955 ft (2,120 m).

Globally

Vegetation within the *Juniperus osteosperma* Woodland Alliance (A.536) is distributed across the Intermountain West from the eastern Sierra Nevada to the central and southern Rocky Mountains. Stands along the Bighorn Range in Wyoming are near the eastern side of the Rockies. The alliance usually occupies semi-arid, lower to middle slopes of the many mountain ranges and plateaus of the region, occurring between 3,281 and 8,694 ft (1,000 and 2,650 m) in elevation. Average annual precipitation is usually between 10-20 in (25-50 cm), but the seasonal distribution varies across the range of the alliance. Generally, winter precipitation in the form of westerly storms is maximal along the northwest edge of the range and summer moisture increases to the east and south. Distribution of the alliance is also correlated with 'thermal belts' which occur above the areas of cold air drainage in high intermountain basins. Adjacent vegetation is usually *Artemisia* shrub-steppe at the lower elevation margin and montane and subalpine coniferous vegetation at the upper margin. Communities in this alliance are often closely associated with *Pinus edulis* or *Pinus monophylla* woodlands. *Juniperus osteosperma* usually forms monotypic stands on drier or colder sites than where the pines occur.

MOST ABUNDANT SPECIES

Walnut Canyon National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis, Pinus monophylla*

ASSOCIATED SPECIES

Walnut Canyon National Monument

Bouteloua gracilis, Penstemon linarioides, Poa fendleriana, Quercus gambelii (all occur with >5% cover)

Globally

Achnatherum hymenoides (= Oryzopsis hymenoides), Amelanchier alnifolia, Artemisia arbuscula, Artemisia nova, Artemisia tridentata, Cercocarpus intricatus, Cercocarpus ledifolius, Cercocarpus montanus, Chrysothamnus spp., *Elymus elymoides, Festuca idahoensis, Juniperus scopulorum, Juniperus monosperma, Pinus aristata, Pinus flexilis, Pinus ponderosa, Pleuraphis jamesii (= Hilaria jamesii), Prunus virginiana, Purshia tridentata, Pseudotsuga menziesii, Pseudoroegneria spicata, Symphoricarpos oreophilus, Stipa* spp., *Quercus gambelii*

VEGETATION DESCRIPTION

Walnut Canyon National Monument

Utah Juniper Woodland Alliance total vegetation cover was 62%, with 47% absolute cover in the tree layer, 10% absolute cover in the shrub layer, and 16% absolute cover in the herbaceous layer. The species diversity, within the one relevé sampled, was 16 species.

The tree layer was dominated by *Juniperus osteosperma* with 35% absolute cover. DBH ranged from 4-12 in (11-30 cm) (average 7 in/19 cm). The shrub layer was not dominated by a single species; however, *Quercus gambelii* was the most common shrub species. *Bouteloua gracilis, Poa fendleriana,* and *Penstemon linarioides* were the most common understory herbaceous species; although, none of these species were dominant within the community.

Globally

These communities are characterized by an open canopy of *Juniperus osteosperma*, quite often in association with *Pinus monophylla* or *Pinus edulis*. The majority of these stands occur in dry ranges or plateaus of the Colorado Plateau or Great Basin. *Cercocarpus ledifolius* is a common associate in these interior stands. Less common tree associates include *Pinus ponderosa, Pinus flexilis, Pinus aristata,* or *Pseudotsuga menziesii*, where these communities grade into montane coniferous forest, or *Juniperus scopulorum*, and *Juniperus monosperma* in the central and southern Rockies. Widespread shrub associates include *Artemisia tridentata, Artemisia arbuscula, Artemisia nova, Symphoricarpos oreophilus, Amelanchier alnifolia*, *Cercocarpus intricatus, Cercocarpus montanus, Chrysothamnus* spp., *Quercus gambelii, Prunus virginiana*, and *Purshia tridentata*. The herbaceous layer is usually somewhat sparse and dominated by cespitose perennial grasses, including *Pseudoroegneria spicata, Festuca idahoensis, Pleuraphis jamesii (= Hilaria jamesii), Achnatherum hymenoides (= Oryzopsis hymenoides), Elymus elymoides*, and *Stipa* spp. Some stands in rocky terrain may lack an understory entirely.

DATABASE CODE A.536

MAP CLASSES

The alliance Utah Juniper Woodland Alliance is represented as an inclusion within map class Pinyon Pine – Utah Juniper / Blue Grama Woodland (map code 12).

The map class Pinyon Pine - Utah Juniper / Blue Grama Woodland has a broad distribution within the eastern section of the project boundary. The total area mapped within Walnut Canyon NM is 373 ac (151 ha) within 43 polygons and the total area in the park environs is 1,732 ac (701 ha) within 98 polygons.

COMMENTS

Walnut Canyon National Monument

This alliance is unique within map class Pinyon Pine–Utah Juniper / Blue Grama Woodland since the alliance is not characterized by pinyon pine, but the map class is. However, due to having only one measured relevé of this alliance, it was not further classified to the association level and was not mapped as a unique map class.

The Pinyon Pine – Utah Juniper / Blue Grama Woodland, as mapped, may combine inclusions of the Utah Juniper Woodland Alliance. Distinction between the two was not possible from aerial photography, but can be possible from the ground where low cover of *Pinus edulis* and high cover of *Juniperus osteosperma* represent Utah Juniper Woodland Alliance and *Pinus edulis* dominating or co-dominating represent the Two-needle Pinyon – (Utah Juniper) Blue Grama Woodland Association.

Globally

The low-elevation woody vegetation of the Great Basin has been classified as *Pinus monophylla* (singleleaf pinyon) or pinyon-juniper woodlands. Further classification work is needed to differentiate true woodlands from wooded herbaceous stands. Many stands described as woodlands have less than 20% cover in the tree layer (Blackburn et al. 1968a & b, Blackburn et al. 1969) and may actually fit better in the *Juniperus osteosperma* Wooded Herbaceous Alliance (A.1502). While the amount of literature available for pinyon-juniper vegetation is large, relatively little classification work has been done for these vegetation types. Further inventory and review of the classification of pinyon-juniper woodlands and wooded herbaceous communities are needed for the entire west.

DYNAMICS

Globally

Juniperus osteosperma is a very slow-growing, long-lived tree and stands appear somewhat static over time compared to more productive forests. *Juniperus osteosperma* stands have always been widespread, but were formerly restricted to certain habitats (rocky ridges, etc.). These woodlands are expanding into adjacent steppe grasslands in many areas, reportedly in connection with livestock grazing and altered fire regimes (Blackburn 1967). *Juniperus osteosperma* is the first to invade adjacent *Artemisia nova* shrublands, but is eventually succeeded by *Pinus monophylla*. Jameson (1962) inferred a similar relationship between *Juniperus osteosperma* and *Pinus edulis* in the Grand Canyon. They noted that individuals of *Juniperus osteosperma* were older and even-aged, while *Pinus edulis* occupied all age classes. Many of these communities have been severely impacted by past range practices of chaining, tilling, and reseeding with exotic forage grasses. Although the dominant trees appear to regenerate after such disturbances, the effects on understory species are poorly known.

REFERENCES

Baker 1983, Baker 1984, Baker and Kennedy 1985, Blackburn 1967, Blackburn et al. 1968a, Blackburn et al. 1968b, Blackburn et al. 1969, Blackburn et al. 1971, Bradley 1964, Brotherson and Evenson 1983, Caicco and Wellner 1983, Clary et al. 1974, Dalen and Snyder 1987, Dastrup 1963, Despain 1973, Donart et al. 1978, Eddleman and Jaindl 1994, Everett 1986, Isaacson 1967, Jameson 1962, Johnsen 1962, Johnson and Pfister 1982, Johnston 1987, Jones 1989, Kline 1973, Knight et al. 1987, Komarkova et al. 1988a, Komarkova et al. 1988b, Koniak 1985, Larson and Moir 1986, Larson and Moir 1987, Lesica and DeVelice 1992, Marriott and Jones 1989, Milton and Purdy 1983, Moir and Carleton 1987, Rust 1999, Sawyer and Keeler-Wolf 1995, USFS 1983a, USFS 1985a, USFS 1985b, Warren n.d., West et al. 1978, Wight 1965, Wight and Fisser 1968

Juniperus scopulorum Woodland Alliance

MAP CLASS	Canyon Floor Complex
COMMON NAME	Rocky Mountain Juniper Woodland Alliance
PHYSIOGNOMIC CLASS	Woodland (II.)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*Juniperus scopulorum* Woodland Alliance

CLASSIFICATION CONFIDENCE LEVEL Alliances are not ranked by NatureServe for classification confidence

USFS WETLAND SYSTEM Upland

RANGE

Walnut Canyon National Monument

Rocky Mountain Juniper Woodland Alliance was located within Walnut Canyon NM on the north rim in a drainage east of the visitor center and within Forest Service lands on a east facing slope on Anderson Mesa.

Globally

Stands included in this woodland alliance occur on dry slopes in the foothills and lower elevations of the northern and southern Rocky Mountains and the Black Hills. The vegetation extends east to breaks, badlands and canyon slopes in the Great Plains in western Nebraska and the Dakotas and may extend south to escarpments in the panhandle of Texas. *Juniperus scopulorum* trees also occur in Puget Sound in northwestern Washington and British Columbia, Canada, but associations have not been described there.

ENVIRONMENTAL DESCRIPTION

Walnut Canyon National Monument

Only two relevés were assigned to this alliance. Elevation was recorded for one of the relevés at 6,660 ft (2,030 m). Both relevés were recorded from steep east facing slopes (20-90% slope).

Globally

Stands included in this woodland alliance occur on dry rocky slopes in the northern and central Rocky Mountains, the Black Hills, and on escarpments and other topographic breaks in the western Great Plains. Elevations range from 2,133-8,694 ft (650-2,650 m). Climate is semi-arid, continental with most of the 16-24 in (40-60 cm) annual precipitation occurring during the growing season. Sites are typically found on moderate to very steep slopes (35-170%) of rock and boulder outcrops in foothill and montane zone in the mountains, and on bluffs along major drainages, escarpments and badlands in the western plains. The stands occur on all aspects, but several associations are restricted to northerly or southerly aspects. Soils are shallow to moderately deep, stony, and typically coarse-textured loams but range from loamy sand to clay. Stands in this alliance grow more robust on calcareous soils (Eyre 1980). Parent material may include limestone, granite, gneiss, schist, sandstone, scoria or shale. Exposed bedrock is common and many stands have over 50% bare soil. Soil pH ranges from slightly acid to alkaline.

MOST ABUNDANT SPECIES

Walnut Canyon National Monument

Stratum	Species
Tree canopy	*Juniperus scopulorum*

Globally

Stratum	Species
Tree canopy	*Juniperus scopulorum*

ASSOCIATED SPECIES

Walnut Canyon National Monument

Bouteloua gracilis, Juniperus osteosperma, Pinus ponderosa, Quercus gambelii (all occur with >5% cover)

Globally

Achillea millefolium, Achnatherum hymenoides (= Oryzopsis hymenoides), Artemisia ludoviciana, Artemisia nova, Artemisia tridentata, Bouteloua gracilis, Carex rossii, Cercocarpus ledifolius, Cercocarpus montanus, Ericameria nauseosa (= Chrysothamnus nauseosus), Eriogonum umbellatum, Campanula rotundifolia, Festuca idahoensis, Fraxinus pennsylvanica, Galium boreale, Helianthus pumilus, Heterotheca villosa, Heuchera bracteata, Hesperostipa comata (= Stipa comata), Leucopoa kingii (= Festuca kingii), Leymus ambiguus, Maianthemum stellatum, Muhlenbergia montana, Opuntia polyacantha Penstemon virens, Physocarpus monogynus, Pinus ponderosa, Piptatherum micranthum (= Oryzopsis micrantha), Poa secunda, Potentilla fissa, Prunus virginiana, Pseudotsuga menziesii, Pseudoroegneria spicata, Purshia tridentata, Rhus trilobata, Ribes spp., *Rubus deliciosus, Symphoricarpos* spp., *Schizachyrium scoparium, Senecio integerrimus*

VEGETATION DESCRIPTION

Walnut Canyon National Monument

Only two relevés were assigned to the Rocky Mountain Juniper Woodland Alliance with total vegetation cover of 38 and 70%, 26 and 46% absolute cover in the tree layer, 4 and 6% absolute cover in the shrub layer, and 15 and 25% absolute cover in the herbaceous layer. The species diversity in the two relevés sample consisted of 19 and 23 species.

The tree layer was dominated by *Juniperus scopulorum*, with 12 and 25% absolute cover and DBH ranging from 4-24 in (11-61cm) (average 10 in/26 cm). The shrub layer was not dominated by a single species; however, *Quercus gambelii* was the most common shrub species. *Bouteloua gracilis* is the most common understory herbaceous species.

Globally

Woodlands in this alliance are found on dry, rocky slopes in the northern and central Rocky Mountains and east into the western Great Plains on topographic breaks. Stands have a sparse to dense canopy of evergreen trees, usually 7-26 ft (2-8 m) tall. The stands are dominated by *Juniperus scopulorum*, a small scale-leaved tree that is typically under 33ft (10 m) tall, but can reach up to 66 ft (20 m). Scattered individuals of *Pinus ponderosa* or *Pseudotsuga menziesii* may be present in the tree canopy, but are never codominant. In the plains stands the deciduous broad-leaved tree *Fraxinus pennsylvanica* may be present.

The understory varies from sparse under closed canopies to a moderately dense layer of shrubs (2-7 ft, 0.5-2 m tall) or graminoids in open stands. The shrub layer may include several species, but is often dominated by a single species on a given aspect. The dominant shrub species are *Artemisia nova, Artemisia tridentata, Cercocarpus ledifolius, Cercocarpus montanus, Prunus virginiana*, and *Purshia tridentata*. Common, but less abundant shrubs include *Ericameria nauseosa (= Chrysothamnus nauseosus), Physocarpus monogynus, Rhus trilobata, Ribes* spp., *Rubus deliciosus*, and *Symphoricarpos* spp. Scattered dwarf-shrubs such as *Artemisia frigida* or *Leptodactylon pungens* are frequently present. The herbaceous layer is dominated by graminoids typical of dry habitats. These species include *Bouteloua gracilis, Carex rossii, Festuca idahoensis, Leucopoa kingii (= Festuca kingii), Leymus ambiguus, Muhlenbergia montana, Achnatherum hymenoides (= Oryzopsis hymenoides), Piptatherum micranthum (= Oryzopsis micrantha), Poa secunda, Pseudoroegneria spicata, Schizachyrium scoparium*, and *Hesperostipa comata (= Stipa comata)*. Perennial forbs are sparse, but may be fairly diverse. The most common forbs are *Achillea millefolium, Artemisia ludoviciana, Eriogonum umbellatum, Campanula rotundifolia, Galium boreale, Helianthus pumilus, Heterotheca villosa, Heuchera bracteata, Maianthemum stellatum, Penstemon virens, Potentilla fissa*, and *Senecio integerrimus*. The fern *Cystopteris fragilis* and the cactus *Opuntia polyacantha* are often present. In some stands mosses and lichens cover up to 72% of the ground. Annual grasses and forbs are seasonally present.

DATABASE CODE A.506

MAP CLASSES

The Rocky Mountain Juniper Woodland Alliance is represented as an inclusion within map class Canyon Floor Complex (map code 10).

This alliance was mapped together with other more mesic and riparian associations as one map class, the Canyon Floor Complex. This map class is distributed mainly within the bottom of Walnut Canyon; however, it also occurs within side canyons and in a small section on Anderson Mesa. The total area mapped within Walnut Canyon NM is 119 ac (48 ha) within 39 polygons and the total area in the park environs is 32 ac (13 ha) within 23 polygons.

The Canyon Floor Complex is represented by the following alliances and associations: *Acer negundo* / *Forestiera pubescens – Symphoricarpos rotundifolius* Temporarily Flooded Shrubland (local assemblage), *Juniperus scopulorum* Woodland Alliance, *Pinus ponderosa / Quercus gambelii* Woodland, *Pseudotsuga menziesii / Quercus gambelii* Forest, *Chamaebatiaria millefolium – Forestiera pubescens* Shrubland (local assemblage), and *Quercus gambelii / Robinia neomexicana / Symphoricarpos rotundifolius* Shrubland.

COMMENTS

Walnut Canyon National Monument

These two relevés were unique within the Canyon Floor Complex due to high cover of *Juniperus scopulorum* and no cover of *Pinus ponderosa* or *Pseudotsuga menziesii*. These relevés could therefore not be further classified with other associations at Walnut Canyon that contain a high cover of *Juniperus scopulorum*, including *Pinus ponderosa / Quercus gambelii* Woodland or *Pseudotsuga menziesii / Quercus gambelii* Forest. Without further sampling of the *Juniperus scopulorum* stands we cannot define the association.

Globally

At their upper elevational limit, *Juniperus scopulorum* communities may merge with woodlands and forests dominated by *Pinus* species. The dominance of *Juniperus scopulorum* is a diagnostic feature that can usually be used to separate communities within this alliance from other wooded communities. At lower elevations, the boundary between *Juniperus scopulorum* woodlands and communities that are dominated by *Artemisia* spp., or dry prairie, may be difficult to distinguish, as the ecotone may be quite broad. On the upper elevation margins, pine woodlands and forests often merge with this alliance. The dominance of *Juniperus scopulorum* is a diagnostic feature that can usually be used to separate communities within this alliance from other wooded communities. At the lower elevation edges of this alliance it may be difficult to distinguish where *Juniperus scopulorum* Woodland Alliance (A.506) ends and communities that are dominated by *Artemisia* spp. or dry prairie begin.

DYNAMICS

Globally

Woodlands in this alliance are considered to be edaphic or topographic climax communities (Tiedemann et al. 1987, Hansen et al. 1984). *Juniperus scopulorum* is a long-lived species. Hansen and Hoffman (1988) found most trees in stands they sampled to be over 120 years, with some individuals older than 360 years. Fire can be used to control *Juniperus scopulorum* stands on rangeland because the species will not resprout after being burned (Fischer and Bradley 1987, Wright et al. 1979). Young individuals are most vulnerable to fire (Fischer and Bradley 1987, Wright et al. 1979). The effect of a fire on a stand is largely dependent on the tree height and density, fine fuel load on the ground, weather conditions, and season (Wright et al. 1979, Dwyer and Pieper 1967). Trees are more vulnerable in open stands where fires frequently occurs in the spring, the humidity is low, wind speeds are over 10-20 mph, and there is adequate fine fuels to carry fire (Fischer and Bradley 1987, Wright et al. 1979). Under other conditions, burns tend to be spotty with low tree mortality. Large trees are generally not killed unless fine fuels, such as tumbleweeds, have accumulated beneath the tree to provide fuel ladders for the fire to reach the crown. Closed-canopy stands rarely burn because they typically do not have enough understory or wind to carry a fire.

Altered fire regimes, cutting trees for fencing, and improper grazing by livestock have significant impacts on the quality of sites. Grazing by livestock can modify the fire regime by removing the fine fuels that carry fire. Fire, livestock grazing, and trampling by hikers and vehicles disturb cryptogamic soil crusts that help maintain soil structure, reduce soil erosion, provide habitat for plants and preserve biological diversity (Ladyman and Muldavin 1996). More study is needed to understand and manage these woodlands.

REFERENCES

Allard 1990, Badaracco 1971, Bighorn Coal Mine n.d., Brown 1971, Burns and Honkala 1990a, Cooper et al. 1995, DeVelice 1992, DeVelice and Lesica 1993, DeVelice et al. 1995, Diamond 1993, Dwyer and Pieper 1967, Eyre

1980, Faber-Langendoen et al. 1996, Fischer and Bradley 1987, Francis 1983, Goodding 1923, Hansen 1985, Hansen and Hoffman 1988, Hansen et al. 1984, Hess 1981, Hess and Alexander 1986, Jennings 1978, Jennings 1979, Johnston 1987, Ladyman and Muldavin 1996, Lesica and DeVelice 1992, Moran 1981, Ramaley 1909, Steele et al. 1983, Strong 1980, Terwilliger et al. 1979, Tiedemann et al. 1987, Wasser and Hess 1982, Wells 1965, Wells 1970a, Wells 1970b, Wright et al. 1979

Pinus edulis - (Juniperus osteosperma) / Bouteloua gracilis Woodland

MAP CLASS	Pinyon Pine – Utah Juniper / Blue Grama Woodland, Limestone Rim Complex
COMMON NAME	Two-needle Pinyon – (Utah Juniper) / Blue Grama Woodland
PHYSIOGNOMIC CLASS	Woodland (II.)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*Pinus edulis – (Juniperus* spp.*)* Woodland Alliance

CLASSIFICATION CONFIDENCE LEVEL Moderate

USFS WETLAND SYSTEM Upland

RANGE

Walnut Canyon National Monument

Two-needle Pinyon – (Utah Juniper) / Blue Grama Woodland is one of the most common associations within the eastern section of the project boundary. It was located on the north rim of Walnut Canyon, mainly to the east of the visitor center, and on the south rim of Walnut Canyon east of Cherry Canyon, within both the environs and Walnut Canyon NM.

Globally

This woodland association occurs in the cinder fields, mountains and mesas in the southern Colorado Plateau and Mogollon Rim, and may extend into southern Utah and western Colorado.

ENVIRONMENTAL DESCRIPTION

Walnut Canyon National Monument

This association's elevation ranged from 1915-2095m (average 1980m). The topography varied from flat areas to steep canyon walls with 0-80% slope (average 28%).

Globally

This woodland association is known from the mountains and mesas in the southern Colorado Plateau, Mogollon Rim and extends into southern Utah and western Colorado. Elevations normally range from 2,100-2,300 m (6,885-7,540 ft). Sites are variable, but generally are relatively dry and rocky. Stands occur on flat to moderate slopes along drainages and on mesa tops, on gentle to moderate 10-40% rocky slopes of foothills, and at the base of cinder cones. The substrates are variable and range from to deep, coarse textured soil derived from cinder, to sandy loams derived from sandstone or fine-textured soils derived from limestone.

MOST ABUNDANT SPECIES

Walnut Canyon National Monument

Stratum	Species
Tree canopy	*Pinus edulis, Juniperus osteosperma*
Herbaceous	*Bouteloua gracilis*

Globally

Stratum	Species
Tree Canopy	*Pinus edulis, Juniperus osteosperma, Juniperus deppeana, Juniperus scopulorum*
Herbaceous	*Bouteloua gracilis*

ASSOCIATED SPECIES

Walnut Canyon National Monument

Chamaebatiaria millefolium, Gutierrezia sarothrae, Poa fendleriana, Purshia mexicana, Purshia stansburiana, Quercus gambelii, Yucca baccata (all occur with >5% cover)

Globally

Achnatherum hymenoides, Bouteloua curtipendula, Cercocarpus montanus, Ericameria nauseosa, Elymus elymoides, Hesperostipa comata, Hesperostipa neomexicana, Juniperus deppeana, Juniperus scopulorum, Koeleria macrantha, Pleuraphis jamesii, Rhus trilobata, Yucca spp.

VEGETATION DESCRIPTION

Walnut Canyon National Monument

Two-needle Pinyon – (Utah Juniper) Blue Grama Woodland total vegetation cover was 23-86% (average 50%) with 13-100% absolute cover (average 39%) in the tree layer, 0.5-21% (average 7%) in the shrub layer, and 5-26% (average 12%) in the herbaceous layer. The total species diversity ranged from 7-29 species (average 17) within the 18 relevés sampled.

The tree layer was co-dominated by *Pinus edulis*, with 4-68% absolute cover (average 27%), and *Juniperus osteosperma*, with 0-51% absolute cover (average 15%). DBH ranged in *Pinus edulis* from 4-24 in (10-62 cm) (average 7 in/18 cm) and in *Juniperus osteosperma* from 4-24 in (11-62 cm) (average 9 in/22 cm). The shrub layer was not dominated by a single species. *Bouteloua gracilis* always occurred within the herbaceous layer; however, it does not always occur as the dominant understory species. *Bouteloua gracilis* is an indicator species within this association and ranges in absolute cover of 1-23% (average 8%).

Globally

This plant association is characterized by an open to moderately dense tree canopy (10-65% cover) co-dominated by *Pinus edulis* and *Juniperus osteosperma*. *Pinus edulis* may be present with relatively small cover in some stands. *Juniperus deppeana* may replace *Juniperus osteosperma* in southern stands. Other species of *Juniperus* such as *J. scopulorum* may be present in higher elevation stands. Shrub cover is sparse (<10% cover). If *Quercus gambelii* is present, it has less than 5% cover. Other associated shrubs may be present such as scattered *Brickellia californica, Cercocarpus montanus, Ericameria nauseosa, Eriogonum corymbosum, Fallugia paradoxa, Gutierrezia sarothrae, Opuntia* spp., *Purshia stansburiana, Rhus trilobata, Ribes cereum* or *Yucca* spp. The herbaceous layer is typically moderately dense and is dominated by the warm-season, perennial short grass, *Bouteloua gracilis*. Associated graminoids include *Aristida* spp., *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua curtipendula, Elymus elymoides, Koeleria macrantha, Hesperostipa comata (= Stipa comata), H. neomexicana (= Stipa neomexicana),* and *Pleuraphis jamesii (= Hilaria jamesii). Muhlenbergia montana* is absent or scarce (<1% cover). Forb cover is typically low, but may be moderately diverse. Species such as *Artemisia dracunculus, Eriogonum* spp., and *Oxytropis lambertii* are common.

CONSERVATION RANK G5

DATABASE CODE CEGL000778

MAP CLASSES

The association Two-needle Pinyon – (Utah Juniper) Blue Grama Woodland is represented by map class Pinyon Pine – Utah Juniper / Blue Grama Woodland (map code 11) and map class Limestone Rim Complex (map code 9), where it occurs on limestone rims.

The association was mapped as part of the map class Pinyon Pine – Utah Juniper / Blue Grama Woodland and includes stands that are dominated solely by *Juniperus osteosperma*, represented by the Utah Juniper Woodland Alliance. This map class was mapped as occurring throughout the eastern half of the project boundary. It was also mapped as occurring on Anderson Mesa within USDA-FS lands. The total area mapped within Walnut Canyon NM is 1,042 ac (422 ha) within 35 polygons and the total area in the park environs is 4,253 ac (1,721 ha) within 90 polygons. This association was also mapped as part of the mosaic of shrubland and woodland associations represented by the map class Limestone Rim Complex. The following shrubland and woodland associations were combined: *Chamaebatiaria millefolium* - (*Mahonia fremontii*) – *Yucca baccata* Limestone Terrace Shrubland

[provisional], *Pinus edulis – (Juniperus* spp.*) / Cercocarpus montanus* Woodland, *Pinus edulis – (Juniperus osteosperma) / Bouteloua gracilis* Woodland, and *Pinus edulis / Purshia stansburiana* Woodland. The total area mapped within Walnut Canyon NM is 591 ac (239 ha) within 34 polygons and the total area in the park environs is 358 ac (145 ha) within 32 polygons.

COMMENTS

Walnut Canyon National Monument

Two-needle Pinyon - Utah Juniper / Blue Grama Woodland association may be dominated by herbaceous species other than *Bouteloua gracilis*. The presence of *Bouteloua gracilis* is an indicator for this association, as currently classified. Further sampling on the Colorado Plateau is needed to determine if *Bouteloua gracilis* is a consistent indicator for this association.

Globally

The two *Pinus edulis / Bouteloua gracilis* plant associations are treated as phases in Stuever and Hayden (1997a). In the NVCS we are including stands with southern Great Plains, Chihuahua Desert floristic affinities in the *Pinus edulis – (Juniperus monosperma) / Bouteloua gracilis* Woodland (CEGL002151) and stands with the Colorado Plateau and Great Basin floristic affinities in the *Pinus edulis – (Juniperus osteosperma) / Bouteloua gracilis* Woodland (CEGL000778). Both of these associations may include stands codominated by *Juniperus deppeana* in their southern extent. Stuever and Hayden (1997a) also described *Juniperus deppeana* phase (recognized by its dominance in the stand) and hillslope phase, which occurs on slopes > 15% and may have low cover of grasses (<5% cover). More survey is needed to fully understands the distribution and ecological relationships between these 3 species of *Juniperus* and *Pinus edulis*.

DYNAMICS

Globally

Pinus edulis is extremely drought-tolerant and slow-growing (Powell 1988, Little 1987, Muldavin et al. 1998). It is also non-sprouting and may be killed by fire (Wright et al. 1979). The effect of a fire on a stand is largely dependent on the tree height and density, fine fuel load on the ground, weather conditions, and season (Wright et al. 1979, Dwyer and Pieper 1967). Trees are more vulnerable in open stands where fires frequently occurs in the spring, the relative humidity is low, wind speeds are over 10-20 mph, and there is adequate fine fuels to carry fire (Wright et al. 1979). Under other conditions, burns tend to be spotty with low tree mortality. Large trees are generally not killed unless fine fuels, such as tumbleweeds, have accumulated beneath the tree to provide ladder fuels for the fire to reach the crown (Jameson 1962). Closed-canopy stands rarely burn because they typically do not have enough understory or wind to carry a fire (Wright et al. 1979).

Altered fire regimes, cutting trees for fencing, and improper grazing by livestock have significant impacts on the quality of sites. Grazing by livestock can modify the fire regime by removing the fine fuels that carry fire. Fire, livestock grazing, and trampling by recreationalists and vehicles disturb cryptogamic soil crusts that help maintain soil structure, reduce soil erosion, provide habitat for plants and preserve biological diversity (Ladyman and Muldavin 1996). More study is needed to understand and manage these woodlands ecologically.

REFERENCES

Bourgeron and Engelking 1994, Dick-Peddie 1986, Driscoll et. al. 1984, Dwyer and Pieper 1967, Hansen et. al. 2003, Jameson 1962, Kennedy 1983, Ladyman and Muldavin 1996, Larsen and Moir 1987, Moir and Carleton 1987, Muldavin et. al. 1998, Powell 1988, Stuever and Hayden 1997a, U.S. Forest Service 1982, Western Ecology Working Group of NatureServe, Wright et. al. 1979, Wright et. al. 1973

Note:

This association is found in two different map classes:

1) Pinyon Pine – Utah Juniper / Blue Grama Woodland
2) Limestone Rim Complex

Pinus edulis - (Juniperus spp.*) / Cercocarpus montanus* Woodland

MAP CLASS	Limestone Rim Complex
COMMON NAME	Two-needle Pinyon Pine - (Juniper species) / Mountain Mahogany Woodland
PHYSIOGNOMIC CLASS	Woodland (II.)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (II.A.4.N)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen forest (II.A.4.N.a)
ALLIANCE	*Pinus edulis* – (*Juniperus* spp.*)* Woodland Alliance

CLASSIFICATION CONFIDENCE LEVEL Moderate

USFS WETLAND SYSTEM Upland

RANGE

Walnut Canyon National Monument

Two-needle Pinyon Pine - (Utah Juniper) / Mountain Mahogany Woodland occurs as a member of a complex of vegetation associations along limestone canyon rim of Walnut Canyon and its side canyons. This association was identified in our relevé data from the northeast rim on the limestone canyon rim in Walnut Canyon NM.

Globally

This widespread woodland association is found from southern Colorado and north-central New Mexico to the Mogollon Rim of Arizona, north across the Colorado Plateau into western Colorado and adjacent Utah.

ENVIRONMENTAL DESCRIPTION

Walnut Canyon National Monument

Only one relevé was sampled for this association. It occurred at the top of a limestone canyon rim in Walnut Canyon at an elevation of 6,463 ft (1,970 m) and with a steep slope of 55%.

Globally

This broadly defined woodland association is common on the Colorado Plateau, occurring on dry foothills and mesas from north-central New Mexico and southern Colorado west to the Mogollon Rim of Arizona, and in extreme northwestern Colorado and adjacent Utah. Elevations range from 6,004-8,005 ft (1830-2440 m). Stands occur on gentle to moderately steep slopes on all aspects. The soils are variable, but generally shallow, poorly developed and skeletal, ranging from clayey marl to sandy loam. Rock outcrop and bare soil are common. Parent materials include sandstone and shale.

MOST ABUNDANT SPECIES

Walnut Canyon National Monument

Stratum	Species
Tree canopy	*Pinus edulis, Juniperus osteosperma*
Shrub	*Cercocarpus montanus*

Globally

Stratum	Species
Tree canopy	*Pinus edulis, Juniperus osteosperma, Juniperus monosperma, Juniperus deppeana, Juniperus scopulorum*
Shrub	*Cercocarpus montanus*

ASSOCIATED SPECIES

Walnut Canyon National Monument
Artemisia ludoviciana, Bouteloua gracilis, Cercocarpus montana, Chamaebatiaria millefolium, Eriogonum jonesii, Gutierrezia sarothrae, Heterotheca villosa, Juniperus osteosperma, Mahonia repens, Rhus trilobata, Symphoricarpos rotundifolius, Yucca baccata (all occur with >1% cover)

Globally
Achnatherum hymenoides, Amelanchier utahensis, Andropogon gerardii, Bouteloua curtipendula, Bouteloua gracilis, Bouteloua hirsuta, Carex rossii, Ephedra viridis, Fendlera rupicola, Garrya ovata, Gutierrezia sarothrae, Hesperostipa comata, Koeleria macrantha, Leymus salinus, Mahonia spp., *Muhlenbergia pauciflora, Nolina microcarpa, Pascopyrum smithii, Pleuraphis jamesii, Poa fendleriana, Pseudoroegneria spicata, Quercus gambelii,Quercus grisea, Rhus trilobata, Schizachyrium scoparium*

VEGETATION DESCRIPTION
Walnut Canyon National Monument
Two-needle Pinyon Pine - (Utah Juniper) / Mountain Mahogany Vegetation total vegetation cover was 40% with 23% absolute cover in the tree layer, 12% in the shrub layer, and 12% in the herbaceous layer. Only one relevé was sampled with a total species diversity of 28 species.

The tree layer was dominated by *Pinus edulis* with 19% absolute cover. DBH ranged from 5-15 in (12-38 cm) (average 6 in/16 cm). The shrub layer was dominated by *Cercocarpus montanus* with absolute cover of 10%. The herbaceous layer was dominated by *Bouteloua gracilis* with absolute cover of 4%.

Globally
This association is characterized by an open to moderately dense tree canopy (10-60% cover) codominated by *Pinus edulis* and *Juniperus* spp. The species of *Juniperus* varies with geography and elevation. *Juniperus monosperma* is common in north-central New Mexico and southern Colorado. *Juniperus deppeana* is common in southern New Mexico, and *Juniperus osteosperma* is common from northwestern New Mexico west into Arizona and north into western Colorado and Utah. *Juniperus scopulorum* is more common in higher elevation stands. *Cercocarpus montanus* dominates the moderately dense short-shrub layer (>25% cover). Other shrubs may be present including *Amelanchier* spp., *Ephedra viridis, Gutierrezia sarothrae, Fendlera rupicola, Garrya ovata, Mahonia* spp., *Nolina microcarpa, Quercus gambelii, Quercus grisea, Rhus trilobata*, or species of *Yucca* and *Opuntia*. Herbaceous cover is variable, ranging from sparse to moderately dense, and generally dominated by graminoids (>5% cover) with scattered forbs. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Andropogon gerardii, Bouteloua curtipendula, Bouteloua gracilis, Bouteloua hirsuta, Carex rossii, Leymus salinus (= Elymus salinus), Hesperostipa comata, Koeleria macrantha, Muhlenbergia pauciflora, Pascopyrum smithii, Pleuraphis jamesii, Poa fendleriana, Pseudoroegneria spicata*, and *Schizachyrium scoparium*. Common forbs include species of *Cryptantha, Eriogonum, Penstemon* and *Phlox*.

CONSERVATION RANK G5

DATABASE CODE CEGL000780

MAP CLASSES
Two-needle Pinyon Pine - (Juniper species) / Mountain Mahogany Woodland is represented within map class Limestone Rim Complex (map code 9).

This association was mapped as part of the mosaic of shrubland and woodland associations represented by Limestone Rim Complex. The following shrubland and woodland associations were combined: *Chamaebatiaria millefolium* - (*Mahonia fremontii*) – *Yucca baccata* Limestone Terrace Shrubland [provisional], *Pinus edulis – (Juniperus* spp.*) / Cercocarpus montanus* Woodland, *Pinus edulis – (Juniperus osteosperma) / Bouteloua gracilis* Woodland, and *Pinus edulis / Purshia stansburiana* Woodland. The total area mapped within Walnut Canyon NM is 591 ac (239 ha) within 34 polygons and the total area in the park environs is 358 ac (145 ha) within 32 polygons.

DYNAMICS

Globally

Fires in this association are thought to be infrequent because *Pinus edulis, Juniperus osteosperma*, and *Juniperus monosperma* are killed or severely damaged by burns and do not resprout (Wright et al. 1979). *Cercocarpus montanus*; however, resprouts after burning and will re-establish relatively quickly (Bradley et al. 1992, Pase and Lindenmuth 1971). Conifers will re-establish more slowly. Stands occur in dry and often rocky habitats where fire frequency is low because of fuel discontinuity. When fire occurs, it will likely be severe because of greater fuel loads from decadent shrubs (Bradley et al. 1992).

REFERENCES

Baker 1983, Baker 1984, Baker and Kennedy 1985, Bourgeron and Engelking 1994, Bradley et al. 1992, Driscoll et al. 1984, Erdman 1962, Erdman 1969, Hess and Wasser 1982, Isaacson 1967, Johnston 1987, Kennedy 1983, Larsen and Moir 1987, Marr et al. 1979, Moir 1963, Moir and Carleton 1987, Moir and Ludwig 1979, Pase and Lindenmuth 1971, Stuever and Hayden 1997a, USFS 1981a, USFS 1981b, USFS 1983a, USFS 1985c, USFS 1985d, USFS 1985e, Vories 1974, Wright et al. 1979

Pinus edulis - (Juniperus osteosperma) / Purshia stansburiana Woodland

MAP CLASS	Limestone Rim Complex
COMMON NAME	Two-needle Pinyon Pine - (Utah Juniper) / Cliffrose Woodland
PHYSIOGNOMIC CLASS	Woodland (II.)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (II.A.4.N)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a)
ALLIANCE	*Pinus edulis* – (*Juniperus* spp.*)* Woodland Alliance

CLASSIFICATION CONFIDENCE LEVEL Strong

USFS WETLAND SYSTEM Upland

RANGE

Walnut Canyon National Monument

Two-needle Pinyon Pine - (Utah Juniper) / Cliffrose Woodland occurs as a member of a complex of vegetation associations along the limestone canyon rim of Walnut Canyon and its side canyons. This association was identified from the southeastern end of Walnut Canyon NM on the limestone canyon rim.

Globally

This woodland association occurs from central Arizona, western New Mexico, southwestern Colorado, and southern Utah.

ENVIRONMENTAL DESCRIPTION

Walnut Canyon National Monument

Only one relevé was sampled for this association. It occurred on the limestone canyon rim of Walnut Canyon at an elevation of 6,332ft (1,930 m) and with a steep slope of 50%.

Globally

This woodland occurs on the Colorado Plateau south to central Arizona. It occurs on dry hillslopes and mesas. Elevations range from 5,988-6,808 ft (1,825-2,075 m). Stands occur on gentle to moderately steep slopes on all aspects. The soils are generally shallow, calcareous and rocky, ranging from sand to sandy loam in texture. Rock outcrop and bare soil are common. Parent materials include sandstone and shale.

MOST ABUNDANT SPECIES

Walnut Canyon National Monument

Stratum	Species
Tree canopy	*Pinus edulis, Juniperus osteosperma*
Shrub	*Purshia stansburiana*

Globally

Stratum	Species
Tree canopy	*Pinus edulis, Juniperus osteosperma*
Shrub	*Purshia stansburiana, Artemisia tridentata*

ASSOCIATED SPECIES

Walnut Canyon National Monument

Arenaria eastwoodiae, Gutierrezia sarothrae, Poa fendleriana, Purshia stansburiana, Rhus trilobata (all occur with >1% cover)

Globally
Achnatherum hymenoides, Artemisia frigida, Artemisia ludoviciana, Amelanchier utahensis, Arctostaphylos patula, Bouteloua curtipendula, Bouteloua gracilis, Bouteloua hirsuta, Calliandra humilis, Chamaebatiaria millefolium, Elymus elymoides, Ephedra viridis, Gutierrezia sarothrae, Hesperostipa comata, Hesperostipa neomexicana, Koeleria macrantha, Mahonia trifoliolata, Penstemon linarioides, Poa fendleriana, Polygala alba, Quercus gambelii (<5% cover), *Schizachyrium scoparium*

VEGETATION DESCRIPTION
Walnut Canyon National Monument
Two-needle Pinyon Pine - (Utah Juniper) / Cliffrose Woodland total vegetation cover was 34%, with 30% absolute cover in the tree layer, 9% in the shrub layer, and 6% in the herbaceous layer. Only one relevé was sampled with total species diversity of 17.

Pinus edulis dominated the tree cover with 23% absolute cover; DBH ranged from 4-17 in (10-43cm) (average 9 in/24 cm). The shrub layer was dominated by *Purshia stansburiana* with absolute cover of 6%. The herbaceous layer was sparse.

Globally
This association is characterized by an open to moderately dense tree canopy (10-60% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*. *Purshia stansburiana* dominates or codominates the sparse to moderately dense short-shrub layer, often with *Artemisia tridentata* in the northern part of its range. *Cercocarpus montanus* and *Purshia tridentata* are scarce or absent. Other shrubs may be present including *Amelanchier utahensis, Arctostaphylos patula, Artemisia tridentata, Chamaebatiaria millefolium, Ephedra viridis, Gutierrezia sarothrae, Mahonia trifoliolata, Quercus gambelii* (<5% cover), or species of *Yucca* and *Opuntia*. Herbaceous cover is variable, ranging from sparse to moderately dense, but generally dominated by graminoids (>5% cover) with scattered forbs. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua curtipendula, Bouteloua gracilis, Bouteloua hirsuta, Elymus elymoides, Hesperostipa comata, Hesperostipa neomexicana, Koeleria macrantha, Poa fendleriana,* and *Schizachyrium scoparium*. Forbs may include *Artemisia ludoviciana, Artemisia frigida, Calliandra humilis, Penstemon linarioides*, and *Polygala alba*.

CONSERVATION RANK G4?

DATABASE CODE CEGL000782

MAP CLASSES
Two-needle Pinyon Pine - (Utah Juniper) / Cliffrose Woodland is represented within map class Limestone Rim Complex (map code 9).

This association is mapped as part of the mosaic of shrubland and woodland associations occurring within the Limestone Rim Complex. The following shrubland and woodland associations were combined: *Chamaebatiaria millefolium* - (*Mahonia fremontii*) – *Yucca baccata* Limestone Terrace Shrubland [provisional], *Pinus edulis – (Juniperus* spp.*) / Cercocarpus montanus* Woodland, *Pinus edulis – (Juniperus osteosperma) / Bouteloua gracilis* Woodland, *and Pinus edulis / Purshia stansburiana* Woodland. The total area of the complex mapped within Walnut Canyon NM is 591 ac (239 ha) within 34 polygons and the total area in the park environs is 358 ac (145 ha) within 32 map classes.

COMMENTS
Globally
Pinus edulis / Purshia mexicana Woodland was changed to *Pinus edulis / Purshia stansburiana* Woodland (CEGL000782) on 2001-09-04 because of a taxonomic change of the nominal species. *Purshia mexicana* var. *stansburiana* (Torr.) Welsh is now recognized as *Purshia stansburiana* (Torr.) Henrickson (Kartesz 1999). *Purshia mexicana* (D. Don) Henrickson, a closely related species, occurs in Chihuahua, Durango and Zacatecas, Mexico, and possibly extreme southern Arizona, and is not known to be present in this association (Cronquist et al. 1997).

DYNAMICS

Globally

Stuever and Hayden (1997a) described two phases of this plant community, an *Artemisia tridentata* phase and a *Purshia stansburiana* phase. Both are restricted geographically with the *Artemisia tridentata* phase common in northern Arizona, southern Utah, northern New Mexico, and southwestern Colorado where winter precipitation is higher than summer, and the *Purshia stansburiana* phase, which lacks *Artemisia tridentata*, occurs in central Arizona where summer monsoon precipitation is higher than winter precipitation (Stuever and Hayden 1997a). Fires in this association are thought to be infrequent because *Pinus edulis, Juniperus osteosperma*, and *Juniperus monosperma* are killed or severely damaged by burns and do not resprout (Wright et al. 1979). *Purshia stansburiana* is also generally killed by fire; however, it is known to resprout after cool burns (Britton and Wright 1983, Wright et al. 1979).

REFERENCES

BIA 1979, Baker 1980a, Baker 1984a, Bourgeron and Engelking 1994, Britton and Wright 1983, Cronquist et al. 1997, Driscoll et al. 1984, Isaacson 1967, Kartesz 1999, Larson and Moir 1987, Moir and Carleton 1987, Northcutt 1978, Stuever and Hayden 1997a, USFS 1982, USFS 1985c

Pinus ponderosa / Bouteloua gracilis Woodland

MAP CLASS	Ponderosa Pine / Mixed Graminoid Woodland Complex
COMMON NAME	Ponderosa Pine / Blue Grama Woodland
PHYSIOGNOMIC CLASS	Woodland (II.)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*Pinus ponderosa* Woodland Alliance

CLASSIFICATION CONFIDENCE LEVEL Strong

USFS WETLAND SYSTEM Upland

RANGE

Walnut Canyon National Monument

Ponderosa Pine / Blue Grama Woodland occurs mainly in the non-canyon upland environments within the project boundary. Our two relevés were located on USDA-FS land in Cherry Canyon and in the northwestern section of the project boundary.

Globally

Ponderosa Pine / Blue Grama Woodland occurs in the southern Rocky Mountains, extending east on southern Great Plains escarpments as far as Oklahoma, south to the mountains of West Texas, west to the Colorado Plateau and Mogollon Rim of New Mexico, Arizona, and southern Utah.

ENVIRONMENTAL DESCRIPTION

Walnut Canyon National Monument

This association occurred between 2045-2065m (average 2,055m). It occurred on flatter areas, with 1-6% slope (average 4%).

Globally

This widespread woodland occurs at foothill and lower montane elevations from the southern Rocky Mountains, extending east on southern Great Plains escarpments, south to the mountains of West Texas, west to the Colorado Plateau and Mogollon Rim of New Mexico, Arizona and Utah. Elevation ranges from 1,740-2,610 m (5,700-8,550 ft). Sites occur on dry, gentle to steep slopes on all aspects, but are more common on southern and western aspects, especially at higher elevations. Substrates are quite variable and include shallow sandy loam soils derived from granitic parent materials, coarse cinder soils and clayey soil with or without high coarse fragment content

MOST ABUNDANT SPECIES

Walnut Canyon National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa*
Herbaceous	*Bouteloua gracilis*

Globally

Stratum	Species
Tree canopy	*Pinus ponderosa Pinus edulis, Juniperus monosperma, Juniperus osteosperma, Juniperus deppeana, Juniperus scopulorum*
Herbaceous	*Bouteloua gracilis*

ASSOCIATED SPECIES

Walnut Canyon National Monument

Artemisia dracunculus, Elymus elymoides, Ericameria nauseosa, Festuca arizonica, Gutierrezia sarothrae, Heliomeris multiflora, Pinus edulis, Juniperus osteosperma, Juniperus scopulorum, Rhus trilobata, Sphaeralcea sp. (all occur with >1% cover)

Globally

Artemisia ludoviciana, Bouteloua hirsuta, Carex geophila, Chaetopappa ericoides, Elymus elymoides, Erigeron spp., *Eriogonum racemosa, Hesperostipa comata, Koeleria macrantha, Muhlenbergia montana, Packera neomexicana, Poa fendleriana, Schizachyrium scoparium*

VEGETATION DESCRIPTION

Walnut Canyon National Monument

Two relevés were sampled in the Ponderosa Pine / Blue Grama Woodland with total cover of 50 and 55%. Absolute cover for the tree layer was 15 and 40%, 3 and 4% in the shrub layer, and 15 and 48% in the herbaceous layer. The total species diversity was 15 and 23 species.

Pinus ponderosa dominated the tree layer with 13 and 41% absolute cover. DBH measurements ranged from 5-52 in (12-130 cm) (average 14 in/35 cm). The shrub layer was sparse. *Bouteloua gracilis* dominated the herbaceous layer with 12 and 40% cover.

Globally

This plant association is characterized by an open to moderately dense, evergreen, needleleaf tree canopy 33-98 ft (10-30 m) tall that is either dominated by *Pinus ponderosa* or codominated by *P. ponderosa* and *P. edulis*. *Juniperus monosperma, J. osteosperma, J. deppeana* or *J. scopulorum* may be important subdominants. The typically moderately dense herbaceous layer has greater cover than the shrub layer, and is dominated by graminoids. *Bouteloua gracilis*, the warm-season, sod-forming, shortgrass dominates the herbaceous layer. Common graminoid associates include *Aristida* spp., *Bouteloua hirsuta, Carex geophila, Elymus elymoides, Hesperostipa comata, Koeleria macrantha, Muhlenbergia montana, Poa fendleriana,* or *Schizachyrium scoparium*. *Quercus gambelii* may be present in the sparse shrub layer (<10% cover) with low cover (<5%). Other shrubs may include scattered *Artemisia tridentata, Ceanothus fendleri, Cercocarpus montanus, Chrysothamnus viscidiflorus, Ericameria nauseosa, Fallugia paradoxa, Purshia tridentata, Quercus grisea, Rhus trilobata,* and *Tetradymia canescens.* Forb cover is typially sparse and may include species such as *Antennaria* spp., *Artemisia ludoviciana, Erigeron* spp., *Eriogonum racemosa,Chaetopappa ericoides, Packera neomexicana*, and *Penstemon* spp.

CONSERVATION RANK G4

DATABASE CODE CEGL000848

MAP CLASSES

The association Ponderosa Pine / Blue Grama Woodland is represented by map class Ponderosa Pine / Mixed Graminoid Complex (map code 15).

It was mapped both on the north and south side of Walnut Canyon, mostly within Forest Service lands on the eastern section of the project boundary. Due to the difficulty in distinguishing understory grasses in photointerpretation the two associations (*Pinus ponderosa / Muhlenbergia montana* Woodland, *Pinus ponderosa / Bouteloua gracilis* Woodland) were mapped as a single map class, the Ponderosa Pine / Mixed Graminoid Woodland. The total area of Ponderosa Pine / Mixed Graminoid Woodland within Walnut Canyon NM is 741 ac (300 ha) within 30 polygons and the total area in the park environs is 4,999 ac (2,023 ha) within 40 polygons.

COMMENTS

Globally

This ponderosa pine woodland is a broadly defined plant association. Stuever and Hayden (1997b) report 6 phases: the *Bouteloua gracilis, Schizachyrium scoparium, Andropogon hallii, Artemisia tridentata, Quercus grisea*, and *Q. gambelii* phases. Hanks et al. (1983) described 4 phases of the *Pinus ponderosa / Bouteloua gracilis* Habitat Type from northern Arizona. More classification review is needed to further define the relationships between these

phases and other similar plant associations. Alexander et al. (1987), DeVelice et al. (1986), and Muldavin et al. (1996) also described phases of this habitat type that need further review and cross-walking to NVCS. Youngblood and Mauk (1985) included stands of this association in their broadly defined *Pinus ponderosa / Muhlenbergia montana* Habitat Type.

DYNAMICS

Globally

Both diagnostic species are tolerant of ground fire. *Pinus ponderosa* develops thick fire-resistant bark that protects it from ground fires (Bradley et al. 1992). *Bouteloua gracilis* resprouts after burning and is unharmed by fires in years with above normal winter and spring precipitation, but can be severely damaged during drought years (Wright and Bailey 1980). Most *Pinus ponderosa* stands have relatively frequent fires (every 3-20 years), but fires are less frequent in dry, rocky stands where ground fire is limited by lack of continuous fine fuels (Stuever and Hayden 1997b). Fire-return interval has generally increased because of active fire suppression and historic livestock grazing, which has reduced the fine-fuels needed to carry ground fires (Madany and West 1980, Savage and Swetnam 1990). Absence of fire has led to large acculmulations of ground fuel and has likely resulted in denser stands and establishmen of less fire-adapted, shade tolerant species species such as *Pseudotsuga menziesii*. This has likely increased risk of severe, stand replacing crown fires.

REFERENCES

Alexander et al. 1987, Bradley et al. 1992, Bourgeron and Engelking 1994, DeVelice et al. 1986, Diamond 1993, Driscoll et al. 1984, Fitzhugh et al. 1987, Francis 1986, Hanks et al. 1983, Hoagland 1997, Johnston 1987, Larson and Moir 1987, Madany and West 1980, Stuever and Hayden 1997b, Youngblood and Mauk 1985, Savage and Swetnam 1990. Wright and Bailey 1980

Pinus ponderosa – (Pinus edulis – Juniperus osteosperma) / Bouteloua gracilis Woodland

MAP CLASS	Ponderosa Pine - Pinyon Pine – Juniper / Blue Grama Woodland
COMMON NAME	Ponderosa Pine (Pinyon Pine – Utah Juniper) / Blue Grama Woodland
PHYSIOGNOMIC CLASS	Woodland (II.)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*Pinus ponderosa* Woodland Alliance

CLASSIFICATION CONFIDENCE LEVEL This association is a variation of the association *Pinus ponderosa / Bouteloua gracilis* Woodland. It is not designated a new association, but a variation of the association *Pinus ponderosa / Bouteloua gracilis* Woodland that has a strong classification confidence level.

USFS WETLAND SYSTEM Upland

RANGE

Walnut Canyon National Monument

Ponderosa Pine (Pinyon Pine–Utah Juniper) / Blue Grama Woodland is one of the most common associations within the central section of the project boundary. It is the dominant association in the central section of the project boundary and occurs mainly in the upland environment. All of our relevé data were identified from south of Walnut Canyon in USDA-FS lands mainly from the central portion of the project boundary.

ENVIRONMENTAL DESCRIPTION

Walnut Canyon National Monument

The elevation of this association ranged from 2010-2075m (average 2,045m). The slope varied from flat areas to hill slopes ranging from 0-25% (average 10%).

MOST ABUNDANT SPECIES

Walnut Canyon National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa, Pinus edulis, Juniperus osteosperma*
Herbaceous	*Bouteloua gracilis*

ASSOCIATED SPECIES

Walnut Canyon National Monument

Festuca arizonica, Gutierrezia sarothrae, Heterotheca villosa, Juniperus scopulorum, Purshia mexicana, Quercus gambelii (all occur with >5% cover)

VEGETATION DESCRIPTION

Walnut Canyon National Monument

Ponderosa Pine (Pinyon Pine – Utah Juniper) / Blue Grama Woodland total vegetation cover ranged from 44-80% (average 58%) with 23-52% absolute cover (average 39%) in the tree layer, 2-18% (average 8%) in the shrub layer, and 17-35% (average 23%) in the herbaceous layer. The total species diversity ranged from 18-31 (average 25) in the 8 relevés sampled.

The tree layer was co-dominated by *Pinus ponderosa* with 8-26% absolute cover (average 15%), *Pinus edulis* with 9-30% cover (average 17%), and *Juniperus osteosperma* with 4-16% cover (average 8%). The DBH for *Pinus ponderosa* was 4-28 in (11-71 cm) (average 10in/26 cm), *Pinus edulis* was 4-16 in (11-41 cm) (average 7 in/19 cm), and *Juniperus osteosperma* was 4-28 in (11-71 cm) (average 9 in/23 cm). A single shrub type did not dominate the shrub layer. The herbaceous layer was dominated by *Bouteloua gracilis* with 9-20% cover (average 15%).

CONSERVATION RANK G4

DATABASE CODE CEGL000848

MAP CLASSES
The association Ponderosa Pine (Pinyon Pine – Utah Juniper) / Blue Grama Woodland is represented by map class Ponderosa Pine - Pinyon Pine - Juniper / Blue Grama Woodland (map code 12).

Ponderosa Pine - Pinyon Pine - Juniper / Blue Grama Woodland was mapped both on the north and south side of Walnut Canyon, mostly within USDA-FS lands on the central and eastern section of the project boundary. The total area of Ponderosa Pine - Pinyon Pine - Juniper / Blue Grama Woodland within Walnut Canyon NM is 373 ac (151 ha) within 43 polygons and the total area in the park environs is 1,732 ac (701 ha) within 98 polygons.

COMMENTS
Walnut Canyon National Monument
This association has a co-dominance of Ponderosa Pine, Pinyon Pine, and Utah Juniper. Previous classifications (Ponderosa Pine Series, Pinyon Pine Series, Juniper Woodlands) have defined vegetation with this co-dominance as occurring in Ponderosa Pine, Pinyon Pine, or Utah Juniper dominated types (Stuever and Hayden 1997b). However, our observations suggest that a new association should be defined based on the co-dominance of all three conifers occurring over a large area within Walnut Canyon NM and in its environs. Currently, this type is treated in the NVCS as the *Pinus edulis* phase of the *Pinus Ponderosa* / *Bouteloua gracilis* Woodland (CEGL000848) (see Stuever and Hayden 1997b).

REFERENCES
Stuever and Hayden 1997b

Pinus ponderosa / Muhlenbergia montana Woodland

MAP CLASS	Ponderosa Pine / Mixed Graminoid Complex
COMMON NAME	Ponderosa Pine / Mountain Muhly Woodland
PHYSIOGNOMIC CLASS	Woodland (II.)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*Pinus ponderosa* Woodland Alliance

CLASSIFICATION CONFIDENCE LEVEL Strong

USFS WETLAND SYSTEM Upland

RANGE

Walnut Canyon National Monument

Ponderosa Pine / Mountain Muhly Woodland was found only in non-canyon environments within the project boundary. This association's relevés were only identified in the western half of the project boundary, mainly at higher elevations north of Walnut Canyon on USDA-FS and Arizona State lands.

Globally

This widespread woodland occurs at foothill and lower montane elevations in the southern Rocky Mountains, extending south to the mountains of West Texas, and west to the Mogollon Rim and Colorado Plateau of New Mexico, Arizona and Utah.

ENVIRONMENTAL DESCRIPTION

Walnut Canyon National Monument

The elevation of this association ranged from 6,791-6,906 ft (2,070-2,105 m) (average 6,890 ft/2,100 m). Topography varied from flat areas to hill slopes 5-35% slope (average 15%).

Globally

This widespread woodland occurs at foothill and lower montane elevations in the southern Rocky Mountains, extending south to the mountains of West Texas, and west to the Mogollon Rim and Colorado Plateau. Elevation ranges from 7,050-9,400 ft (2,150-2,870 m). Stands occur on bottomlands, elevated plains, cinder cones, piedmont slopes, mesas, foothills, and mountains. Sites include gentle to steep slopes on all aspects, but are more common on southern and western aspects, especially at higher elevations. Substrates are variable, but are typically shallow, rocky, coarse-textured soils derived from granitic or cinder parent materials. There is considerable cover of bare soil and exposed bedrock.

MOST ABUNDANT SPECIES

Walnut Canyon National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa*
Herbaceous	*Muhlenbergia montana*

Globally

Stratum	Species
Tree canopy	*Pinus ponderosa*
Herbaceous	*Muhlenbergia montana*

ASSOCIATED SPECIES

Walnut Canyon National Monument

Bouteloua gracilis, Brickellia grandiflora, Festuca arizonica, Juniperus osteosperma, Juniperus scopulorum, Poa fendleriana, Rhus trilobata (all occur with >5% cover)

Globally

Artemisia ludoviciana, Artemisia tridentata, Blepharoneuron tricholepis, Bouteloua gracilis, Brickellia californica, Carex geophila, Carex rossii, Ceanothus fendleri, Cercocarpus montanus, Chaetopappa ericoides, Chrysothamnus viscidiflorus, Elymus elymoides, Ericameria nauseosa, Eriogonum racemosa, Fallugia paradoxa, Juniperus deppeana, Juniperus monosperma, Juniperus osteosperma, Juniperus scopulorum, Koeleria macrantha, Lotus wrightii, Mahonia spp., *Oxytropis lambertii, Packera neomexicanaPinus discolor, Pinus edulis, Poa fendleriana, Purshia tridentata, Quercus grisea, Rhus trilobata, Schizachyrium scoparium, Tetradymia canescens, Yucca baccata*

VEGETATION DESCRIPTION

Walnut Canyon National Monument

Ponderosa Pine / Mountain Muhly Woodland total vegetation cover ranged from 44-80% (average 53%) with 20-55% absolute cover (average 36%) in the tree layer, 1-5% (average 3%) in the shrub layer, and 12-36% (average 23%) in the herbaceous layer. The total species diversity ranged from 17-38 (average 26) in the 7 relevés sampled.

Pinus ponderosa dominated the tree layer with 14-40% absolute cover (average 27%), and DBH of 5-28 in (12-71 cm) (average 13 in/32 cm). The shrub layer was sparse. *Muhlenbergia montana* dominated the herbaceous layer with 5-15% absolute cover (average 10%).

Globally

This association is characterized by an open to moderately dense, evergreen, needleleaf tree canopy to 33-98 ft (10-30 m) tall that is dominated or codominated by *Pinus ponderosa*. Associated tree species vary geographically. *Pinus edulis, Pinus discolor, Juniperus monosperma, J. osteosperma, J. deppeana* and *J.scopulorum* may be important in the tree canopy. *Psudotsuga menziesii, Pinus flexilis*, and *Populus tremuloides* may also be present, but are considered accidental. The typically moderately dense herbaceous layer has greater cover than the shrub layer, and is dominated by graminoids. *Muhlenbergia montana,* a warm-season, medium-tall perennial typically dominates the herbaceous layer and is diagnostic of this association. Common graminoid associates include *Aristida* spp., *Blepharoneuron tricholepis, Bouteloua gracilis, Carex geophila, C. rossii, Elymus elymoides, Koeleria macrantha, Poa fendleriana* and *Schizachyrium scoparium*. *Festuca arizonica, Muhlenbergia virescens, M. dubia, M. emersleyi* and *Hesperostipa* spp. are typically absent. *Quercus gambelii* may be present with low cover (to 5%) in the sparse shrub layer (<10% cover). Other scattered shrubs may includle *Artemisia tridentata, Brickellia californica, Ceanothus fendleri, Cercocarpus montanus, Chrysothamnus viscidiflorus, Ericameria nauseosa, Fallugia paradoxa, Mahonia* spp., *Purshia tridentata, Quercus grisea, Rhus trilobata, Tetradymia canescens* or *Yucca baccata*. Forb cover is typially sparse and may include species such as *Antennaria* spp., *Artemisia ludoviciana, Erigeron* spp., *Eriogonum racemosa, Chaetopappa ericoides, Lotus wrightii, Oxytropis lambertii, Packera neomexicana,* and *Penstemon* spp.

CONSERVATION RANK G4G5

DATABASE CODE CEGL000862

MAP CLASSES

The association Ponderosa Pine / Mountain Muhly Woodland is represented by map class Ponderosa Pine / Mixed Graminoid Woodland Complex (map code 15).

Ponderosa Pine / Mixed Graminoid Woodland Complex was mapped both on the north and south side of Walnut Canyon, mainly in non-canyon upland environments. Due to the difficulty in distinguishing understory grasses in photointerpretation the two associations (*Pinus ponderosa / Muhlenbergia montana* Woodland, *Pinus ponderosa / Bouteloua gracilis* Woodland) were mapped as a single map class, the Ponderosa Pine / Mixed Graminoid Woodland Complex. The total area of Ponderosa Pine / Mixed Graminoid Woodland within Walnut Canyon NM is 741 ac (300 ha) within 30 polygons and the total area in the park environs is 4,999 ac (2,023 ha) within 40 polygons.

COMMENTS

Globally

This ponderosa pine woodland is a broadly defined plant association. Stuever and Hayden (1997b) suggested the xeric upland and mesic bottomland stands be put into different phases. Fitzhugh et al. (1987) suggested it be divided into regional phases.

DYNAMICS

Globally

Both diagnostic species are tolerant of ground fire. *Pinus ponderosa* develops thick fire-resistant bark and *Muhlenbergia montana* resprouts after burning, although it may take a few years to recover to pre-burn density (Fischer and Bradley 1987, Bradley et al. 1992). This association had frequent fires (every 3-10 years on average) in pre-settlement times, but fires are less frequent in dry, rocky stands where ground fire is limited by lack of continuous fine fuels (Stuever and Hayden 1997b). Fire-return interval has generally increased because of active fire suppression and historic livestock grazing, which has reduced the fine-fuels needed to carry ground fires (Madany and West 1980, Savage and Swetnam 1990). Absence of fire has led to large acculmulations of ground fuel and has likely resulted in denser stands and invasion of less fire-adapted, shade tolerant species species such as *Pseudotsuga menziesii*. This has likely increased risk of stand replacing crown fires

Improper livestock grazing will favor the more grazing-tolerant species such as *Bouteloua gracilis*, and over time can eliminate *Muhlenbergia montana* and convert the stand into a *Pinus ponderosa* / *Bouteloua gracilis* Woodland (CEGL000848).

REFERENCES

Alexander et al. 1987, Bourgeron and Engelking 1994, Bradley et al. 1992, Costello 1944a, DeVelice 1983, DeVelice and Ludwig 1983, DeVelice et al. 1986, Diamond 1993, Driscoll et al. 1984, Fischer and Bradley 1987, Fitzhugh et al. 1987, Hanks et al. 1983, Hess 1981, Hess and Alexander 1986, Madany and West 1980, Johnston 1987, Larson and Moir 1987, Peet 1981, Savage and Swetnam 1990, Stuever and Hayden 1997b, Terwilliger et al. 1979, Wasser and Hess 1982, Youngblood and Mauk 1985

Pinus ponderosa / Quercus gambelii Woodland

MAP CLASS	Ponderosa Pine / Gambel Oak Woodland, Canyon Floor Complex
COMMON NAME	Ponderosa Pine / Gambel Oak Woodland
PHYSIOGNOMIC CLASS	Woodland (II.)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*Pinus ponderosa* Woodland Alliance

CLASSIFICATION CONFIDENCE LEVEL Strong

USFS WETLAND SYSTEM Upland

RANGE

Walnut Canyon National Monument

Ponderosa Pine / Gambel Oak Woodland is a common association within Walnut Canyon NM and in the environs. It is found, from our relevé data, to occur in riparian habitats as well as in non-canyon environments in the western section of the park. The riparian mesic relevés were located in Walnut Canyon as well as in its side canyons, specifically occurring in Cherry Canyon. The non-canyon relevés were found on the north rim west of the visitor's center and on the south rim west of Anderson Mesa.

Globally

This ponderosa pine woodland association is widespread in the southern Rocky Mountains and southwestern U.S. and occurs in foothills, mountains and plateaus from Colorado to Trans-Pecos, Texas, west to Arizona and Nevada.

ENVIRONMENTAL DESCRIPTION

Walnut Canyon National Monument

This association ranged from 6,430-7,218 ft (1,960-2,200 m) (average 6,791 ft/2,070 m). The topography varied from steep canyon walls to flat areas with 0-80% slope (average 17%).

Globally

This woodland association is widespread and has been reported from foothills, mountains and plateaus from Colorado to Trans-Pecos Texas, west to Arizona and Nevada. Elevation ranges from 1,830-2,800 m (6,000-9,200 ft). Stands often occur along drainages, on lower and middle slopes and benches on all aspects. Slopes are typically gentle or moderate, but may also be steep (>45%). Soils are typically shallow and rocky ranging from sandy loams to clay loams. Parent materials are commonly sandstones, but fractured limestone, basalt, andesite, and alluvium are also reported. High litter cover (70-90%) about 2 in (5 cm) deep is common in many stands. Rock outcrop (about 10%) and some bare soil are not uncommon. This conifer woodland transitions to *Quercus gambelii* Shrubland in drier sites and at lower elevations. This community is the highest elevation *Pinus ponderosa* / *Quercus gambelii* Woodland present in Trans-Pecos, Texas. There, it typically grades downslope to *Pinus ponderosa* / *Quercus hypoleucoides* Woodland (CEGL000872).

MOST ABUNDANT SPECIES

Walnut Canyon National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa*
Tall Shrub	*Quercus gambelii*

Globally

Stratum	Species
Tree canopy	*Pinus ponderosa, Pinus strobiformis*
Tall Shrub	*Quercus gambelii*

ASSOCIATED SPECIES

Walnut Canyon National Monument

Bouteloua curtipendula, Bouteloua gracilis, Elymus elymoides, Juniperus osteosperma, Juniperus scopulorum, Poa fendleriana, Pseudotsuga menziesii, Rosa woodsii, Robinia neomexicana, Symphoricarpos rotundifolius (all occur with >5% cover)

Globally

Amelanchier spp., *Arctostaphylos patula, Artemisia ludoviciana, Artemisia tridentata* ssp. *vaseyana, Balsamorhiza sagittata, Bouteloua gracilis, Carex geyeri, Carex rossii, Cercocarpus montanus, Elymus elymoides, Erigeron* spp., *Eriogonum* spp., *Festuca arizonica, Hymenoxys* spp., *Juniperus communis, Juniperus deppeana, Juniperus osteosperma, Juniperus scopulorum, Koeleria macrantha, Lithosperma multiflorum, Mahonia repens, Muhlenbergia longiligula, Muhlenbergia montana, Packera multilobata, Pinus edulis, Pinus strobiformis, Poa fendleriana, Robinia neomexicana, Rosa woodsii, Schizachyrium scoparium, Shepherdia rotundifolia, Symphoricarpos oreophilus, Wyethia amplexicaulis*

VEGETATION DESCRIPTION

Walnut Canyon National Monument

Ponderosa Pine / Gambel Oak Woodland total cover was 30-90% (average 61%) with 15-78% absolute cover (average 48%) in the tree layer, 1-35% (average 9%) in the shrub layer, and 5-48% (average 17%) in the herbaceous layer. The total species diversity ranged from 20-40 species (average 25) within the 16 relevés sampled.

Pinus ponderosa dominated the tree layer with 13-35% absolute cover (average 25%). DBH ranged from 4-48 in (11-122 cm) (average 13 in/33 cm). *Quercus gambelii* dominated the shrub layer with 3-34% absolute cover (average 13%); DBH ranged from 4-19 in (11-49 cm) (average 7 in/17 cm). The herbaceous layer contained a variety of herbs and grasses.

Globally

This broadly defined coniferous woodland is widespread and is characterized by a sparse to moderately dense, evergreen needleleaf tree canopy dominated by *Pinus ponderosa* or sometimes co-dominated by *Pinus edulis* with scattered *Juniperus scopulorum*, *J. monosperma*, or *J. osteosperma*. In southern stands *Juniperus deppeana* and *Pinus strobiformis* may be present to co-dominant. *Pseudotsuga menziesii* is accidental and *Abies concolor* is not present. *Quercus gambelii* dominates both the subcanopy (tree form, if present) and the typically moderately dense tall-shrub layer, which consists of dense clumps of oak. This community must have at least 5% cover of *Quercus gambelii*, but there is frequently over 25%. At higher elevations, the *Quercus gambelii* are more tree-like and *Symphoricarpos oreophilus* will be present with significant cover in a short-shrub layer. At lower elevations, scattered *Artemisia tridentata* ssp. *vaseyana*, *Pinus edulis*, and *Juniperus osteosperma* are often present. Other common shrub species may include *Arctostaphylos patula*, *Amelanchier* spp., *Cercocarpus montanus*, *Juniperus communis*, *Mahonia repens*, *Robinia neomexicana*, *Rosa woodsii*, and *Shepherdia rotundifolia*. The herbaceous layer is generally sparse (<10% cover), but may equal the shrub cover. It is composed of mostly graminoids such as *Bouteloua gracilis*, *Elymus elymoides*, *Festuca arizonica*, *Koeleria macrantha*, *Muhlenbergia longiligula*, *Muhlenbergia montana*, *Poa fendleriana*, *Schizachyrium scoparium*, and *Carex* spp., especially *Carex geyeri* and *Carex rossii*. Scattered forbs include *Artemisia ludoviciana*, *Balsamorhiza sagittata*, *Eriogonum* spp., *Erigeron* spp., *Hymenoxys* spp., *Lithosperma multiflorum*, *Packera multilobata*, and *Wyethia amplexicaulis.*

CONSERVATION RANK G5

DATABASE CODE CEGL000870

MAP CLASSES

The association Ponderosa Pine / Gambel Oak Woodland is represented by map classes Ponderosa Pine / Gambel Oak Woodland (map code 14) and Canyon Floor Complex (map code 10).

The distinguishing feature between the upland map class Ponderosa Pine / Gambel Oak Woodland and the riparian map class Canyon Floor Complex is that the Canyon Floor Complex occurs in more mesic riparian areas. Ponderosa Pine / Gambel Oak Woodland was mapped as occurring in the southwestern half of the project boundary in non-canyon environments and side canyons. The Canyon Floor Complex was mapped as occurring on the canyon

bottom of Walnut Canyon. The total area of Ponderosa Pine / Gambel Oak Woodland within Walnut Canyon NM is 198 ac (80 ha) within 22 polygons and the total area in the park environs is 1,695 ac (686 ha) within 35 polygons. The total area of Canyon Floor Complex within Walnut Canyon NM is 119 ac (48 ha) within 39 polygons and the total area in the park environs is 32 ac (13 ha) within 23 polygons.

COMMENTS

Walnut Canyon National Monument

Due to Walnut Canyon and the adjacent side canyons being narrow, it was difficult to distinguish the occurrence of this association on the aerial photography. Therefore, this association, when it occurs on the canyon bottom, is mapped as part of the Canyon Floor Complex map class.

Globally

This ponderosa pine woodland is a broadly defined plant association. Stuever and Hayden (1997b) report 7 phases for this plant association: the *Quercus gambelii*, *Festuca arizonica*, *Muhlenbergia longiligula*, *Pinus edulis*, *Muhlenbergia montana*, *Bouteloua gracilis*, and *Robinia neomexicana* phases. More classification review is needed to further define the relationships between these phases and other similar plant associations.

DYNAMICS

Globally

Pinus ponderosa is a drought-resistant, shade-intolerant conifer that when mature has thick bark that allows it to withstand ground fires (Bradley et al. 1992). Natural fire frequency is estimated to be 3-20 years for this community (Youngblood and Mauk 1985). *Quercus gambelii* is a fire-adapted species with a well developed root system that draws moisture from a large volume of soil, and allows for rapid resprouting after fire (Clary 1992). Both species are well-adapted to relatively frequent ground fires that prevent *Pseudotsuga menziesii* or *Abies concolor* from regenerating.

These woodlands grade into *Abies concolor* / *Quercus gambelii* Forest (CEGL000261) or *Pseudotsuga menziesii* / *Quercus gambelii* Forest (CEGL000452) as sites become cooler and wetter (DeVelice et al. 1986). Mosaics of *Pinus ponderosa* stands with grass- or oak-dominated understories occur in response to different substrates with *Quercus gambelii* dominating the rocky sites and grass understory woodland types (*Festuca* spp., *Muhlenbergia montana*) in areas with deeper soils (DeVelice et al. 1986, Peet 1981).

REFERENCES

Alexander et al. 1984, Alexander et al. 1987, Bader 1932, Blackburn et al. 1969, Bourgeron and Engelking 1994, Bradley et al. 1992, Bunin 1975, Clary 1992, DeVelice et al. 1986, Diamond 1993, Dixon 1935, Donart et al. 1978, Driscoll et al. 1984, Fitzhugh et al. 1987, Hanks et al. 1983, Hanson and Ball 1928, Harmon 1980, Helm 1977, Hess and Wasser 1982, Madany and West 1980, Muldavin et al. 1996, Johnston 1987, Johnston and Hendzel 1985, Larson and Moir 1987, Marr et al. 1973, Muldavin et al. 1996, Peet 1975, Peet 1981, Roberts et al. 1992, Schmoll 1935, Somers et al. 1980, Stuever and Hayden 1997b, Savage and Swetnam 1990, Terwilliger et al. 1979a, USFS 1983b, Wasser and Hess 1982, Wright et al. 1973, Youngblood and Mauk 1985

Note:

This association is found in two different map classes:

1) Canyon Floor Complex
2) Ponderosa Pine / Gambel Oak Woodland

Pinus ponderosa – (*Pinus edulis–Juniperus osteosperma*) / *Quercus gambelii* Woodland

MAP CLASS	Ponderosa Pine – Pinyon Pine – Juniper / Gambel Oak Woodland
COMMON NAME	Ponderosa Pine (Pinyon Pine–Utah Juniper) Gambel Oak Woodland
PHYSIOGNOMIC CLASS	Woodland (II.)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*Pinus ponderosa* Woodland Alliance

CLASSIFICATION CONFIDENCE LEVEL This association is a variation of the association *Pinus ponderosa / Quercus gambelii* Woodland. It is not designated as an association, but a variation of the association *Pinus ponderosa / Quercus gambelii* Woodland that has a strong confidence classification level.

USFS WETLAND SYSTEM Upland

RANGE
Walnut Canyon National Monument
Ponderosa Pine (Pinyon Pine - Utah Juniper) / Gambel Oak Woodland occurs in small patches in the non-canyon environments of Walnut Canyon and its environs as well as in the more mesic side canyons of Walnut Canyon. It was located from our relevé data to occur only on the south side of Walnut Canyon, specifically on and west of Anderson Mesa.

ENVIRONMENTAL DESCRIPTION
Walnut Canyon National Monument
The elevation of this association ranged from 2050-2150m (average 2110m). Topography varied from flat areas to hill slopes, ranging from 5-30% slope (average 20%).

MOST ABUNDANT SPECIES
Walnut Canyon National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa, Pinus edulis, Juniperus osteosperma*
Tall Shrub	*Quercus gambelii*

ASSOCIATED SPECIES
Walnut Canyon National Monument
Amelanchier utahensis, Bouteloua gracilis, Poa fendleriana (all occur with >5% cover)

VEGETATION DESCRIPTION
Walnut Canyon National Monument
Ponderosa Pine (Pinyon Pine – Utah Juniper) / Gambel Oak Woodland total cover ranged from 65-76% (average 72%) with 52-65% absolute cover (average 58%) in the tree layer, 2-15% (average 9%) in the shrub layer, and 14-24% (average 17%) in the herbaceous layer. The total species diversity ranged from 20-30 (average 25) within the 4 relevés sampled.

The tree layer was co-dominated by *Pinus ponderosa* with 4-11% absolute cover (average 7%), *Pinus edulis* with 4-34% cover (average 19%), and *Juniperus osteosperma* with 7-18% cover (average 13%). The DBH for *Pinus ponderosa* was 5-26 in (12-67 cm) (average 11 in/28 cm), *Pinus edulis* was 4-11 in (11-29 cm) (average 6 in/16 cm), and *Juniperus osteosperma* was 5-40 in (12-102 cm) (average 11 in/28 cm). The shrub layer was dominated by *Quercus gambelii* with 9-27% cover (average 22%). The herbaceous layer was not dominated by a single herbaceous species.

CONSERVATION RANK G5

DATABASE CODE CEGL000870

MAP CLASSES
The association Ponderosa Pine (Pinyon Pine – Utah Juniper) / Gamble Oak Woodland is represented by the map class Ponderosa Pine – Pinyon Pine – Juniper / Gambel Oak Woodland (map code 13).

Ponderosa Pine – Pinyon Pine – Juniper / Gambel Oak Woodland was mapped as occurring mainly south of the canyon, only in small patches in the environs. It was mostly in the non-canyon environments and in side canyon drainages. The total area of Ponderosa Pine – Pinyon Pine – Juniper / Gambel Oak Woodland in the park environs is 366 ac (148 ha) within 28 polygons.

COMMENTS
Walnut Canyon National Monument
This association has a co-dominance of Ponderosa Pine, Pinyon Pine, and Utah Juniper. Previous classifications (Ponderosa Pine Series, Pinyon Pine Series, Juniper Woodlands) have defined vegetation with this co-dominance as occurring in Ponderosa Pine, Pinyon Pine, or Utah Juniper dominated types (Stuever and Hayden 1997b). However, our observations suggest that a new association should be defined based on the co-dominance of all three conifers occurring over a large area within Walnut Canyon NM and in its environs. Currently, this type is treated in the NVCS as the *Pinus edulis* phase of the *Pinus Ponderosa* / *Quercus gambelii* Woodland (CEGL000870) (see Stuever and Hayden 1997b). Hanks et al. 1983 treats this type as a *Quercus gambelii* phase of the *Pinus ponderosa / Festuca arizonica* habitat type and a *Pinus ponderosa / Bouteloua gracilis* habitat type.

REFERENCES
Stuever and Hayden 1997b

Acer negundo / Forestiera pubescens – Symphoricarpos rotundifolius Temporarily Flooded Shrubland (Local Assemblage)

MAP CLASS	Canyon Floor Complex
COMMON NAME	Box Elder / New Mexican Olive – Snowberry Temporarily Flooded Shrubland

CLASSIFICATION CONFIDENCE LEVEL Not Rated, Unique to Monument

USFS WETLAND SYSTEM Wetland

RANGE
Walnut Canyon National Monument
Box Elder / New Mexican Olive – Snowberry Temporarily Flooded Shrubland occurs as a part of a complex of vegetation associations along riparian corridors, specifically in Walnut Canyon and its side canyons. This assemblage was located from our relevé data at the lower elevations within the northeastern section of Walnut Canyon.

ENVIRONMENTAL DESCRIPTION
Walnut Canyon National Monument
The elevation of the assemblage ranged minimally from 6,201-6,234 ft (1,890-1,900 m). It only occurred on flat areas ranging from 0-3% slope.

MOST ABUNDANT SPECIES
Walnut Canyon National Monument

Stratum	Species
Tree canopy	*Acer negundo*
Shrub	*Forestiera pubescens, Symphoricarpos rotundifolius*

ASSOCIATED SPECIES
Walnut Canyon National Monument
Solidago canadensis, Rhus trilobata, Salix lasiolepis, Robinia neomexicana, Artemisia dracunculus (all occur with >5% cover)

VEGETATION DESCRIPTION
Walnut Canyon National Monument
Box Elder / New Mexican Olive – Snowberry Temporarily Flooded Shrubland total vegetation cover was 74 and 78%. The tree layer was 17 and 26% absolute cover, 50 and 65% in the shrub layer, and 5 and 12% in the herbaceous layer. Only two relevés were sampled and the total species diversity was 39 and 42 species.

The tree layer was dominated by *Acer negundo* with 8 and 17% absolute cover and with DBH measurements of 4 and 10 in (11 and 26 cm). The shrub layer was dominated by *Forestiera pubescens* with 11 and 15% absolute cover and *Symphoricarpos rotundifolius* with 9 and 10%. The herbaceous layer was sparse and not dominated by a single herbaceous species.

CONSERVATION RANK N/A (local assemblage)

DATABASE CODE N/A (local assemblage)

MAP CLASSES
Box Elder / New Mexican Olive – Snowberry Temporarily Flooded Shrubland is represented within the map class of Canyon Floor Complex (map code 10).

Due to this vegetation assemblage occurring within a narrow, linear riparian corridor, it was mapped together with the riparian associations as one map class, the Canyon Floor Complex. The following shrubland and woodland

associations were combined: *Acer negundo / Forestiera pubescens–Symphoricarpos rotundifolius* Temporarily Flooded Shrubland (local assemblage), *Pinus ponderosa / Quercus gambelii* Woodland, *Juniperus scopulorum* Woodland, *Pseudotsuga menziesii / Quercus gambelii* Forest, *Chamaebatiaria millefolium – Forestiera pubescens* Shrubland (local assemblage), and *Quercus gambelii / Robinia neomexicana / Symphoricarpos rotundifolius* Shrubland. The total area of Canyon Floor Complex within Walnut Canyon NM is 119 ac (48 ha) within 39 polygons and the total area in the park environs is 32 ac (13 ha) within 23 polygons.

COMMENTS

Walnut Canyon National Monument

Although this assemblage has only two relevés, its unique species composition and habit suggest that it may be a new community type. Observations and descriptions of additional occurrences are required to confirm it as a provisional association within the NVCS.

Chamaebatiaria millefolium – Forestiera pubescens Shrubland (Local Assemblage)

MAP CLASS Canyon Floor Complex
COMMON NAME Fernbush – New Mexican Olive Shrubland

CLASSIFICATION CONFIDENCE LEVEL Not Rated, Unique to Monument

USFS WETLAND SYSTEM Upland

RANGE
Walnut Canyon National Monument
Fernbush – New Mexican Olive Shrubland occurs as part of a complex of vegetation types along the canyon bottom of Walnut Canyon and its side canyons. This assemblage was described from one relevé in a mesic side canyon in the northeastern section of Walnut Canyon on a limestone wall.

ENVIRONMENTAL DESCRIPTION
Walnut Canyon National Monument
Only one relevé was sampled with this vegetation. It occurred on a limestone wall in a side canyon at an elevation of 6,463 ft (1,970 m) and with a moderately steep slope of 23%.

MOST ABUNDANT SPECIES
Walnut Canyon National Monument

Stratum	Species
Shrub	*Chamaebatiaria millefolium, Forestiera pubescens*

ASSOCIATED SPECIES
Walnut Canyon National Monument
Artemisia dracunculus, Bouteloua gracilis, Brickellia californica, Cercocarpus montanus, Eriogonum corymbosum var. *aureum, Gutierrezia sarothrae, Heterotheca villosa, Juniperus monosperma, Mahonia repens, Poa fendleriana* (all occur with >1% cover)

VEGETATION DESCRIPTION
Walnut Canyon National Monument
Fernbush – New Mexican Olive Shrubland total vegetation cover was 31%, with 2% absolute cover in the tree layer, 18% in the shrub layer, and 15% in the herbaceous layer. Only one relevé was sampled with total species diversity of 28 species.

The tree layer was sparse. The shrub layer was dominated by *Chamaebatiaria millefolium* with absolute cover of 12% and *Forestiera pubescens* with absolute cover of 5%. The herbaceous layer was not dominated by any single species.

CONSERVATION RANK N/A (local assemblage)

DATABASE CODE N/A (local assemblage)

MAP CLASSES
Fernbush – New Mexican Olive Shrubland is represented within map class Canyon Floor Complex (map code 10).

Due to this assemblage occurring within narrow linear riparian corridors, it was mapped together with other riparian associations as one map class, the Canyon Floor Complex. The following shrubland and woodland associations were combined: *Acer negundo / Forestiera pubescens–Symphoricarpos rotundifolius* Temporarily Flooded Shrubland (local assemblage), *Pinus ponderosa / Quercus gambelii* Woodland, *Juniperus scopulorum* Woodland, *Pseudotsuga menziesii / Quercus gambelii* Forest, *Chamaebatiaria millefolium – Forestiera pubescens* Shrubland (local assemblage), and *Quercus gambelii / Robinia neomexicana / Symphoricarpos rotundifolius* Shrubland. The

total area of Canyon Floor Complex within Walnut Canyon NM is 119 ac (48 ha) within 39 polygons and the total area in the park environs is 32 ac (13 ha) within 23 polygons.

COMMENTS

Walnut Canyon National Monument

Although this assemblage has only two relevés, a unique species composition and habit suggest that it may be a new community type. Observations and descriptions of additional occurrences are required to confirm it as a provisional association within the NVCS.

Chamaebatiaria millefolium - (Mahonia fremontii) - Yucca baccata Limestone Terrace Shrubland (Proposed)

MAP CLASS	Limestone Rim Complex
COMMON NAME	Fernbush – (Barberry) – Banana Yucca Limestone Terrace Shrubland
PHYSIOGNOMIC CLASS	Shrubland (III.)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (III.B.2.N.)
FORMATION	Temperate cold-deciduous shrubland (III.B.2.N.a.)
ALLIANCE	*Chamaebatiaria millefolium* Shrubland Alliance

CLASSIFICATION CONFIDENCE LEVEL Weak

USFS WETLAND SYSTEM Upland

RANGE
Walnut Canyon National Monument
Fernbush – (Barberry) – Banana Yucca Limestone Terrace Shrubland occurs as part of a complex of vegetation associations along limestone canyon terrace walls of Walnut Canyon and its side canyons. This association was identified from our relevé data on the limestone terraces on the canyon walls on the north rim of Walnut Canyon in Walnut Canyon NM.

ENVIRONMENTAL DESCRIPTION
Walnut Canyon National Monument
The association occurred from 1950-2070m (average 2000). This association only occurred on limestone terraces with steep slopes ranging from 55-85% (average 65%).

MOST ABUNDANT SPECIES
Walnut Canyon National Monument

Stratum	Species
Shrub	*Chamaebatiaria millefolium, Mahonia fremontii, Yucca baccata*

ASSOCIATED SPECIES
Walnut Canyon National Monument
Cercocarpus montanus, Juniperus osteosperma, Juniperus scopulorum, Quercus gambelii (all occur with >5% cover)

VEGETATION DESCRIPTION
Walnut Canyon National Monument
Fernbush – (Barberry) – Banana Yucca Limestone Terrace Shrubland total vegetation cover ranges from 38-65% (average 51%), with 4-17% absolute cover (average 10%) in the tree layer, 14-45% (average 24%) in the shrub layer, and 12-25% (average 19%) in the herbaceous layer. The total species diversity ranged from 18-34 (average 24) within the 4 relevés sampled.

The tree layer is not characterized by one species: At least 5% cover of *Juniperus osteosperma*, *Juniperus scopulorum*, or *Quercus gambelii* occurred in at least one of the relevés measured. The shrub layer was co-dominated by *Chamaebatiaria millefolium* ranging from 1-7% absolute cover (average 5%), *Mahonia fremontii* ranging from 1-17% absolute cover (average 7%), and *Yucca baccata* ranging from 2-7% absolute cover (average 4%). The herbaceous layer was sparse and not dominated by a single herbaceous species.

CONSERVATION RANK G?

DATABASE CODE CEGL003494

MAP CLASSES
Fernbush – (Barberry) – Banana Yucca Limestone Terrace Shrubland is represented within map class Limestone Rim Complex (map code 9).

This association was mapped as part of a complex of associations on the limestone canyon walls, the Limestone Rim Complex. Due to difficulty in the photo-delineation of the steep limestone cliffs, the following shrubland and woodland associations were combined: *Chamaebatiaria millefolium* – (*Mahonia fremontii)* – *Yucca baccata* Limestone Terrace Shrubland [provisional], *Pinus edulis* / *Cercocarpus montanus* Woodland, *Pinus edulis* – *(Juniperus osteosperma)* / *Bouteloua gracilis* Woodland, and *Pinus edulis* – *(Juniperus osteosperma)* / *Purshia stansburiana* Woodland. The total area of the complex mapped within Walnut Canyon NM is 591 ac (239 ha) within 34 polygons and the total area in the park environs is 358 ac (145 ha) within 32 polygons.

COMMENTS
Walnut Canyon National Monument
Observations and descriptions of additional occurrences of this association are required to increase its classification confidence level as an association within the NVCS.

Ericameria nauseosa - Gutierrezia sarothrae Shrubland (Local Assemblage)

MAP CLASS Snakeweed / Modified Grassland Complex
COMMON NAME Rabbitbrush – Snakeweed Shrubland

CLASSIFICATION CONFIDENCE LEVEL Not Rated, Unique to Monument

USFS WETLAND SYSTEM Upland

RANGE
Walnut Canyon National Monument
Rabbitbrush – Snakeweed Shrubland occurs within a complex of disturbed vegetation associations in the northeast section of the project boundary. *Ericameria nauseosa* and *Gutierrezia sarothrae* are both native species that often thrive in areas of disturbance. Only one relevé from this proposed association was identified on USDA-FS lands between the Walnut Canyon Park Road and Cosnino Road.

ENVIRONMENTAL DESCRIPTION
Walnut Canyon National Monument
Only one relevé of this assemblage was surveyed; it was found at an elevation of 6,562 ft (2,000 m) in a flat area.

MOST ABUNDANT SPECIES
Walnut Canyon National Monument

Stratum	Species
Shrub	*Ericameria nauseosa, Gutierrezia sarothrae*

ASSOCIATED SPECIES
Walnut Canyon National Monument
Amaranthus sp., *Aristida purpurea*, *Bouteloua gracilis*, *Bromus* sp., *Erodium cicutarium*, *Erigeron divergens*, *Machaeranthera gracilis*, *Portulaca oleracea*, *Verbascum thapsus* (all occur with >1% cover)

VEGETATION DESCRIPTION
Walnut Canyon National Monument
Only one relevé was sampled of the Rabbitbrush – Snakeweed Shrubland. Total vegetation cover was 57% with <1% in the tree layer, 26% in the shrub layer, and 23% in the herbaceous layer. The total species diversity was 22.

Gutierrezia sarothrae and *Ericameria nauseosa* dominated the shrub layer with both species having absolute cover of 12%. The herbaceous layer was not dominated by a single species, rather a conglomeration of many different species.

CONSERVATION RANK N/A (local assemblage)

DATABASE CODE N/A (local assemblage)

MAP CLASSES
Rabbitbrush – Snakeweed Shrubland is represented by map class Snakeweed / Modified Grassland Complex (map code 7).

This assemblage occurs in a mosaic of disturbed areas, mainly on chained areas in the project environs. Due to difficulty in the photo-delineation of the chained area mosaic, the following grassland and shrubland associations were mapped in this unit: *Gutierrezia sarothrae* Modified Dwarf-shrub Herbaceous Vegetation, *Bromus* (*tectorum, rubens*) Semi-natural Herbaceous Alliance, *Aristida purpurea* Herbaceous Vegetation, *Bouteloua eriopoda* Herbaceous Vegetation, and *Ericameria nauseosa – Gutierrezia sarothrae* Shrubland (local assemblage). The total area of this complex within Walnut Canyon NM is 101 ac (41 ha) within 10 polygons and the total area in the park environs is 2,417 ac (978 ha) within 28 polygons.

COMMENTS

Walnut Canyon National Monument

Alliances and associations characteristic of disturbed areas have not been well studied in the NVCS. Further study will allow for better classification of the vegetation classification of disturbed areas. Observations and descriptions of additional occurrences of *Ericameria nauseosa – Gutierrezia sarothrae* Shrubland are required to confirm it as a proposed association within the NVCS.

Quercus gambelii / Robinia neomexicana / Symphoricarpos rotundifolius Shrubland

MAP CLASS	Canyon Floor Complex
COMMON NAME	Gambel Oak - New Mexico Locust - Roundleaf Snowberry Shrubland
PHYSIOGNOMIC CLASS	Shrubland (III.)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (III.B.2.N.)
FORMATION	Temperate cold-deciduous shrubland (III.B.2.N.a.)
ALLIANCE	*Quercus gambelii* Shrubland Alliance

CLASSIFICATION CONFIDENCE LEVEL Weak

USFS WETLAND SYSTEM Upland

RANGE

Walnut Canyon National Monument

Gambel Oak - New Mexico Locust - Roundleaf Snowberry Shrubland occurs from drier cooler slopes to areas with periodic flooding within Walnut Canyon NM and the surrounding USDA-FS lands. It was identified specifically from our relevé data in side drainages of Walnut Canyon, on the more mesic canyon rims of Walnut Canyon, and on the cooler canyon walls of Walnut Canyon.

Globally

This association is reported from central New Mexico and northern central Arizona along the Mogollon Rim.

ENVIRONMENTAL DESCRIPTION

Walnut Canyon National Monument

This association occurs at a wide range of elevations, from 4,957-6,857 ft (1,511-2,090 m) (average 5,774 ft/1,760 m). All of the relevés were found within side drainages or on steep north facing slopes ranging from 5-48% slope (average 19%).

Globally

This poorly known shrubland association is reported from the Sandía Mountains in north-central New Mexico and the Mogollon Rim in central Arizona. Elevation ranges from 4,950-10,000 ft (1,510-3,050 m). Sites include steep, exposed sites at higher elevations or north aspect midslopes and riparian areas in canyons at lower elevations. Slopes and aspects are variable. Substrates are generally coarser textured soils with a high percentage of mixed gravel, cobble and/or boulder sized rock. Litter cover is often over 10%.

MOST ABUNDANT SPECIES

Walnut Canyon National Monument

Stratum	Species
Tall Shrub	*Quercus gambelii, Robinia neomexicana, Symphoricarpos rotundifolius* var. *parishii*

Globally

Stratum	Species
Tall Shrub	*Quercus gambelii, Robinia neomexicana,*
Short Shrub	*Symphoricarpos rotundifolius, S. oreophilus,* or *S. palmeri*

ASSOCIATED SPECIES

Walnut Canyon National Monument

Amelanchier utahensis, Bromus sp., *Helianthus petiolaris, Poa fendleriana, Rhus trilobata, Vitis arizonica* (all occur with >5% cover)

Globally
Pinus edulis, Pinus ponderosa, Pseudotsuga menziesii, Juniperus scopulorum, J. osteosperma,, J. monosperma,, Acer negundo, Amelanchier utahensis, Chamaebatiaria millefolium, Forestiera pubescens, Rosa woodsii, Salix spp., *Achillea millefolium, Artemisia ludoviciana, Campanula rotundifolia, Hedeoma drummondii, Heterotheca villosa, Penstemon* spp., *Poa fendleriana, Solidago velutina, Thalictrum fendleri*

VEGETATION DESCRIPTION
Walnut Canyon National Monument
Gambel Oak - New Mexico Locust - Roundleaf Snowberry Shrubland total vegetation cover ranged from 45-94% (average 72%) with 4-94% absolute cover (average 34%) in the tree layer, 20-75% (average 48%) in the shrub layer, and 7-50% (average 30%) in the herbaceous layer. The total species diversity ranged from 11-32 species (average 23) within the 4 relevés sampled.

The tree and shrub layer were dominated or co-dominated by *Quercus gambelii* with 4-80% absolute cover (average 26%) in the tree layer and 1-15% absolute cover (average 10%) in the shrub layer. DBH in the tree layer ranged from 4-10 in (11-26 cm) (average 6 in/15 cm). The shrub layer was also co-dominated by *Symphoricarpos rotundifolius* var. *parishii* with 7-46% absolute cover (average 18%). *Robinia neomexicana* often occurs in high cover within the shrub layer, but does not need to be present (0-22% absolute cover (average 12%)). The herbaceous layer contained a high diversity of herbaceous species including *Bromus* sp., *Helianthus petiolaris, Poa fendleriana,* and *Vitis arizonica;* however, no single species dominated this layer.

Globally
This association is characterized by a moderately dense to dense, deciduous tall shrub layer that is dominated by *Quercus gambelii* with *Robinia neomexicana* often co-dominating. Scattered conifer trees may be present including *Pinus edulis, Pinus ponderosa, Pseudotsuga menziesii, Juniperus scopulorum, J. osteosperma,,* or *J. monosperma.* Riparian stands may have occasional *Acer negundo* trees or *Salix* spp. shrubs. The short shrub layer is dominated by species of *Symphoricarpos* that vary depending on geography such as *S. rotundifolius, S. oreophilus,* or *S. palmeri*. Other shrubs may include *Amelanchier utahensis, Chamaebatiaria millefolium, Forestiera pubescens,* or *Rosa woodsii*. The herbaceous layer is generally sparse because of shading from dense shrub cover. Associates include *Achillea millefolium, Artemisia ludoviciana, Campanula rotundifolia, Hedeoma drummondii, Heterotheca villosa, Penstemon* spp., *Poa fendleriana, Solidago velutina,* and *Thalictrum fendleri.*

CONSERVATION RANK GU

DATABASE CODE CEGL001116

MAP CLASSES
The association Gambel Oak - New Mexico Locust - Roundleaf Snowberry Shrubland is represented by map class Canyon Floor Complex (map code 10).

Canyon Floor Complex was mapped as occurring as small patches along the canyon bottom of Walnut Canyon. The Canyon Floor Complex consists of a tight mosaic of the following associations: *Acer negundo* / *Forestiera pubescens – Symphoricarpos rotundifolius* Temporarily Flooded Shrubland (local assemblage), *Quercus gambelii / Robinia neomexicana / Symphoricarpos rotundifolius* Shrubland, *Juniperus scopulorum* Woodland Alliance, *Pinus ponderosa / Quercus gambelii* Woodland, *Chamaebatiaria millefolium – Forestiera pubescens* Shrubland (local assemblage), and *Pseudotsuga menziesii / Quercus gambelii* Forest. The total area of Canyon Floor Complex within Walnut Canyon NM is 119 ac (48 ha) within 39 polygons and the total area in the park environs is 32 ac (13 ha) within 23 polygons.

COMMENTS
Walnut Canyon National Monument
This association is currently being reviewed by NatureServe to determine the differences between three similar vegetation associations: *Quercus gambelii / Robinia neomexicana / Symphoricarpos rotundifolius* Shrubland, *Quercus gambelii / Robinia neomexicana* Shrubland, and *Quercus gambelii / Symphoricarpos oreophilus* Shrubland. If there is revision of these associations, our current assignment may need to be reviewed.

Our relevé data also contained two taxonomically similar species, *Symphoricarpos rotundifolius* var. *parishii* and *Symphoricarpos oreophilus.* Both of these species are know to occur in the canyon bottom of Walnut Canyon (Joyce 1974). Although both of these species are know to occur, we believe that they are taxonomically similar and were combined for the analysis. *Symphoricarpos rotundifolius* is the most common of the species to occur in Walnut Canyon and this allowed us to maintain the nomenclature previously identified in the *Quercus gambelii / Robinia neomexicana / Symphoricarpos rotundifolius* Shrubland association description.

Globally
This poorly known plant association is reported both as chaparral from Sandía Mountains in New Mexico and riparian vegetation canyons in northern Arizona. It is similar to stands of *Quercus gambelii / Robinia neomexicana* Shrubland (CEGL001115) described from the Mazatzal Mountains in central Arizona (Warren and Treadwell 1980) and stands of *Quercus gambelii / Symphoricarpos oreophilus* Shrubland (CEGL001117) described from White Sands Missile Range in New Mexico (Muldavin et al. 2000). These related stands are all dominated by *Quercus gambelii* with *Symphoricarpos* spp. and *Robinia neomexicana* potentially present. Further review is needed to better understand this association and its relationship to the other associations.

DYNAMICS
Globally
Seems to occur on sites at higher elevation that are too dry for conifer trees to dominate, and on relatively mesic sites at lower elevation.

REFERENCES
Bourgeron and Engelking 1994, Driscoll et. al. 1984, Muldavin et. al. 2000, Warren and Treadwell 1980, Watson 1912, Western Ecology Working Group of NatureServe

Gutierrezia sarothrae Modified Dwarf-shrubland [Provisional]

MAP CLASS	Snakeweed / Modified Grassland Complex
COMMON NAME	Snakeweed Modified Dwarf-Shrub Herbaceous Vegetation
PHYSIOGNOMIC CLASS	Dwarf-shrubland (IV)
PHYSIOGNOMIC SUBCLASS	Deciduous dwarf-shrubland (IV.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous dwarf-shrubland (IV.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (IV.B.2.N.)
FORMATION	Cespitose cold-deciduous dwarf-shrubland (V.A.8.N.a.)
ALLIANCE	*Gutierrezia sarothrae* Dwarf-Shrubland

CLASSIFICATION CONFIDENCE LEVEL Weak

USFS WETLAND SYSTEM Upland

RANGE
Walnut Canyon National Monument
Snakeweed Modified Dwarf-Shrub Herbaceous Vegetation is a common vegetation association in the northeast section of the project boundary. This association was identified from our relevé data in the northeastern section of the project boundary on USDA-FS lands that were previously chained. These areas previously supported *Juniperus monosperma*, which were chained to increase the forage potential of the site for grazing (USDA Forest Service Rangelands 2004). This association was also identified south of Walnut Canyon on Forest Service lands in the southeastern section of the project boundary.

ENVIRONMENTAL DESCRIPTION
Walnut Canyon National Monument
This association occurred from 1970-2110m (average 2020m). Topography varied from flat areas to hills, 0-12% slope (average 7%).

MOST ABUNDANT SPECIES
Walnut Canyon National Monument

Stratum	Species
Shrub	*Gutierrezia sarothrae*

ASSOCIATED SPECIES
Walnut Canyon National Monument
Bouteloua gracilis, Chamaebatiaria millefolium, Marrubium vulgare, Pascopyrum smithii, Pinus edulis, Portulaca oleracea, Purshia stansburiana (all occur with >5% cover)

VEGETATION DESCRIPTION
Walnut Canyon National Monument
Snakeweed Modified Dwarf-Shrub Herbaceous Vegetation total vegetation cover ranged from 38-68% (average 46%) with 0-18% absolute cover (average 6%) in the tree layer, 13-26% (average 19%) in the shrub layer, and 9-29% (average 23%) in the herbaceous layer. The total species diversity ranged from 14-41 (average 23) within the 6 relevés sampled.

The tree layer was sparse with occasional *Pinus edulis* and *Juniperus osteosperma*. The shrub layer was dominated by *Gutierrezia sarothrae* ranging from 3-17% cover (average 10%). The herbaceous layer was dominated by annual and perennial weedy species such as *Portulaca oleracea, Pascopyrum smithii*, and *Marrubium vulgare* and also supported remnant native grasses such as *Bouteloua gracilis*.

CONSERVATION RANK G?

DATABASE CODE to be determined

MAP CLASSES

The association Snakeweed Modified Dwarf-Shrub Herbaceous Vegetation is represented by the map class Snakeweed / Modified Grassland Complex (map code 7).

The chained areas are a mosaic of grasslands and shrublands that have been mapped as a single map class, Snakeweed / Modified Grassland Complex. It consists of the following vegetation types which occurred in a tight mosaic in the landscape: *Gutierrezia sarothrae* Modified Dwarf-shrubland [provisional], *Bromus* (*tectorum, rubens*) Semi-natural Herbaceous Alliance, *Aristida purpurea* Herbaceous Vegetation, *Bouteloua eriopoda* Herbaceous Vegetation, and *Ericameria nauseosa – Gutierrezia sarothrae* Shrubland (local assemblage). The total area of this complex within Walnut Canyon NM is 101 ac (41 ha) within 10 polygons and the total area in the park environs is 2,417 ac (978 ha) within 28 polygons.

COMMENTS

Walnut Canyon National Monument

Disturbed alliances and associations have not been well defined in the NVCS; therefore, further study will allow for better classification of the alliances and associations.

Ericameria nauseosa / Bouteloua gracilis Shrub Herbaceous Vegetation

MAP CLASS	Rabbitbrush / Blue Grama Shrub Herbaceous Vegetation
COMMON NAME	Rabbitbrush / Blue Grama Shrub Herbaceous Vegetation
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V.)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland with a sparse shrub layer (V.A.7.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (V.A.7.N.)
FORMATION	Short temperate or subpolar grassland with a sparse microphyllous shrub layer (V.A.7.N.j.)
ALLIANCE	*Ericameria nauseosa* Shrub Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL Weak

USFS WETLAND SYSTEM Upland

RANGE
Walnut Canyon National Monument
Rabbitbrush / Blue Grama Shrub Herbaceous Vegetation is a common vegetation association in eastern section of the project boundary. This association was identified from our relevé data to occur in the northeastern section of the project boundary near the chained areas as well as in small patches in the southeastern section of the project boundary east of Cherry Canyon.

ENVIRONMENTAL DESCRIPTION
Walnut Canyon National Monument
The elevation at which this association was surveyed ranged from 1935-2010m (average 1980m). Topography varied from flat areas to slight inclines of 0-13% slope (average 4%).

MOST ABUNDANT SPECIES
Walnut Canyon National Monument

Stratum	Species
Shrub	*Ericameria nauseosa*
Herbaceous	*Bouteloua gracilis*

ASSOCIATED SPECIES
Walnut Canyon National Monument
Aristida purpurea, Artemisia dracunculus, Chamaebatiaria millefolium, Gutierrezia sarothrae, Juniperus osteosperma, Linaria genistifolia, Pinus edulis, Tetradymia canescens (all occur with >1% cover)

VEGETATION DESCRIPTION
Walnut Canyon National Monument
Rabbitbrush / Blue Grama Shrub Herbaceous Vegetation total vegetation cover ranged from 52-62% (average 57%) with 1-9% absolute cover (average 3%) in the tree layer, 18-32% (average 25%) in the shrub layer, and 28-40% (average 32%) in the herbaceous layer. The total species diversity ranged from 14-35 (average 24) within the 7 relevés sampled.

The tree layer was sparse with occasional *Pinus edulis* and *Juniperus osteosperma*. The shrub layer was dominated by *Ericameria nauseosa* ranging in cover from 9-22% (average 17%). *Gutierrezia sarothrae* occurred in all relevés, often with low cover (1-13%, average 5%). The herbaceous layer was dominated by *Bouteloua gracilis* with absolute cover ranging from 20-30% (average 26%).

CONSERVATION RANK G?

DATABASE CODE CEGL003495

MAP CLASSES

The association Rabbitbrush / Blue Grama Shrub Herbaceous Vegetation is represented by map class Rabbitbrush / Blue Grama Shrub Herbaceous Vegetation (map code 8).

This association was mapped on Forest Service lands and at Walnut Canyon NM on the north rim in areas that were previously chained and on the south rim at lower elevations adjacent to Pinyon Pine – Utah Juniper / Blue Grama Woodland map class. The total area of Rabbitbrush / Blue Grama Shrub Herbaceous Vegetation within Walnut Canyon NM is 37 ac (15 ha) within 13 polygons and the total area in the park environs is 418 ac (169 ha) within 56 polygons.

REFERENCES

Francis 1986, Western Ecology Working Group of NatureServe

Aristida purpurea Herbaceous Vegetation

MAP CLASS	Snakeweed / Modified Grassland Complex
COMMON NAME	Purple Three-Awn Herbaceous Vegetation
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V.)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (V.A.5.N.)
FORMATION	Medium-tall bunch temperate or subpolar grassland (V.A.5.N.d)
ALLIANCE	*Aristida purpurea* Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL Weak

USFS WETLAND SYSTEM Upland

RANGE
Walnut Canyon National Monument
Purple Three-Awn Herbaceous Vegetation occurs as a part of a complex of disturbed vegetation associations in the northeast section of the project boundary. *Aristida purpurea* is an effective colonizer of disturbed areas and occurs within the mosaic of disturbed associations in the project environs. Only one relevé was assigned to this association and it occurred on the chained areas were *Juniperus monosperma* was removed to increase the forage potential of the site for grazing (USDA Forest Service Rangelands 2004). This area also has natural disturbance resulting from a large prairie dog colony.

ENVIRONMENTAL DESCRIPTION
Walnut Canyon National Monument
Only one relevé in this association; it was at 1970m in a flat area.

MOST ABUNDANT SPECIES
Walnut Canyon National Monument

Stratum	Species
Herbaceous	*Aristida purpurea*

ASSOCIATED SPECIES
Walnut Canyon National Monument
Artemisia dracunculus, Bouteloua gracilis, Ericameria nauseosa, Senecio spartioides, Sphaeralcea sp., *Verbascum thapsus* (all occur with >1% cover)

VEGETATION DESCRIPTION
Walnut Canyon National Monument
Purple Three-Awn Herbaceous Vegetation total vegetation cover was 63%, with 8% absolute cover in the shrub layer and 55% in the herbaceous layer. Only one relevé was sampled with total species diversity of 21 species.

The shrub layer was dominated by *Ericameria nauseosa* with absolute cover of 6%. The herbaceous layer was dominated by *Aristida purpurea* with absolute cover of 42%.

CONSERVATION RANK G?

DATABASE CODE CEGL005800

MAP CLASSES
Purple Three-Awn Herbaceous Vegetation is represented by the map class Snakeweed / Modified Grassland Complex (map code 7).

Snakeweed / Modified Grassland Complex was mapped mainly in the northeastern section of the project boundary in highly disturbed environments. Due to the difficulty in photo-delineation of the chained area mosaic, the following grassland and shrubland associations were mapped together: *Gutierrezia sarothrae* Modified Dwarf-shrubland [provisional], *Bromus* (*tectorum, rubens*) Semi-natural Herbaceous Alliance, *Aristida purpurea* Herbaceous Vegetation, *Bouteloua eriopoda* Herbaceous Vegetation, and *Ericameria nauseosa – Gutierrezia sarothrae* Shrubland (local assemblage). The total area of this complex within Walnut Canyon NM is 101 ac (41 ha) within 10 polygons and the total area in the park environs is 2,417 ac (978 ha) within 28 polygons.

COMMENTS

Walnut Canyon National Monument

Disturbed alliances and associations have not been defined in the NVCS; therefore, further study will allow for better classification of the alliances and associations.

Globally

A provisional alliance has been described from disturbed sites in the eastern plains of Colorado.

REFERENCES

Western Ecology Working Group of NatureServe

Bouteloua eriopoda Semi-desert Herbaceous Vegetation

MAP CLASS	Snakeweed / Modified Grassland Complex
COMMON NAME	Black Grama Semi-desert Herbaceous Vegetation
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V.)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A..)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (V.A.5.N.)
FORMATION	Short sod temperate or subpolar grassland (V.A.5.N.e.)
ALLIANCE	*Bouteloua eriopoda* Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL Weak

USFS WETLAND SYSTEM Upland

RANGE

Walnut Canyon National Monument

Black Grama Semi-desert Herbaceous Vegetation occurs as part of a complex of disturbed vegetation associations in the northeast section of the project boundary. Only one relevé of this association was sampled and it occurred as a remnant patch of native grass within the mosaic of disturbed associations on chained areas in the project environs. Here *Juniperus monosperma* was chained to increase the forage potential of the site for grazing (USDA Forest Service Rangelands 2004).

Globally

This association occurs in south-central New Mexico and northern Arizona in the Chihuahuan Desert and Colorado Plateau.

ENVIRONMENTAL DESCRIPTION

Walnut Canyon National Monument

Only one relevé of this association was surveyed; it was at 6,463 ft (1,970 m) in a flat area.

Globally

This grassland occurs on semi-arid plains and bajadas in the Chihuahuan Desert and Colorado Plateau. Elevation ranges from 4,920-6,475 ft (1,500-1,975 m). Sites are flat to gentle lower slopes. Soils are non-calcareous sandy loams.

MOST ABUNDANT SPECIES

Walnut Canyon National Monument

Stratum	Species
Herbaceous	*Bouteloua eriopoda*

Globally

Stratum	Species
Herbaceous	*Bouteloua eriopoda, Allionia incarnata*

ASSOCIATED SPECIES

Walnut Canyon National Monument

Gutierrezia sarothrae, Robinia neomexicana, Senecio flaccidus (all occur with >5% cover)

Globally

Ephedra trifurca, Gutierrezia sarothrae, Robinia neomexicana, Aristida purpurea, Bouteloua curtipendula, Muhlenbergia porteri, Allionia incarnata, Datura wrightii, Opuntia phaeacantha, Senecio flaccidus, Solanum elaeagnifolium

VEGETATION DESCRIPTION

Walnut Canyon National Monument

Black Grama Semi-desert Herbaceous Vegetation total vegetation cover was 54%, with 18% absolute cover in the shrub layer and 40% in the herbaceous layer. Only one relevé was sampled with total species diversity of 10 species.

The shrub layer was dominated by *Robinia neomexicana* with absolute cover of 7%. The herbaceous layer was dominated by *Bouteloua eriopoda* with absolute cover of 38%.

Globally

This association is characterized by a moderately dense herbaceous layer dominated by the perennial shortgrass *Bouteloua eriopoda*, sometimes forming nearly pure stands. Shrubs or dwarf-shrubs may be present in low cover such as *Ephedra trifurca, Gutierrezia sarothrae,* or *Robinia neomexicana.* Common associates include *Aristida purpurea, Bouteloua curtipendula, Muhlenbergia porteri, Allionia incarnata, Datura wrightii, Eriogonum* spp, *Opuntia phaeacantha, Senecio flaccidus,* and *Solanum elaeagnifolium.*

CONSERVATION RANK G2Q

DATABASE CODE CEGL001752

MAP CLASSES

Black Grama Semi-desert Herbaceous Vegetation is represented by the map class Snakeweed / Modified Grassland Complex (map code 7).

The mosaic of grassland and shrubland associations has been lumped as a map class, the Snakeweed / Modified Grassland Complex. The following grassland and shrubland associations were combined in this map class: *Gutierrezia sarothrae* Modified Dwarf-shrubland [provisional], *Bromus* (*tectorum, rubens*) Semi-natural Herbaceous Alliance, *Aristida purpurea* Herbaceous Vegetation, *Bouteloua eriopoda* Herbaceous Vegetation, and *Ericameria nauseosa - Gutierrezia sarothrae* Shrubland (local assemblage). The total area of this complex within Walnut Canyon NM is 101 ac (41 ha) within 10 polygons and the total area in the park environs is 2,417 ac (978 ha) within 28 polygons.

COMMENTS

Walnut Canyon National Monument

Bouteloua eriopoda was originally the dominant forage grass in numerous areas in the southwest (USDA 1988). However, *Bouteloua eriopoda* does not withstand heavy grazing regimes and may die out in extensive drought periods (USDA 1998). The small remnant patch of *Bouteloua eriopoda* in the project boundary may be representative of larger stands that once dominated these grasslands.

Globally

This association is not well known, based only on 6 relevés on the Jornada Experimental Range in south-central New Mexico and 1 relevé from Walnut Canyon National Monument in northern Arizona. More survey and classification work is needed to better define this type. This association needs to be compared with *Ephedra trifurca / Bouteloua eriopoda* Shrub Herbaceous Vegetation (CEGL001732) described by Muldavin et al. 2000.

DYNAMICS

Globally

The abundance of *Bouteloua eriopoda*-dominated grasslands has declined significantly in the last 50 years (Buffington and Herbel 1965, Gardner 1950, Hennessy et al. 1983, Herbel et al. 1972, Nelson 1934). These grasslands have been replaced largely by shrublands dominated by *Prosopis glandulosa* in Trans Pecos, southern New Mexico and southeastern Arizona. Studies on the Jornada Experimental Range suggest that combinations of drought, overgrazing by livestock, wind and water erosion, seed dispersal by livestock, fire suppression, shifting dunes, and changes in the seasonal distribution of precipitation have caused this recent, dramatic shift in vegetation physiognomy (Buffington and Herbel 1965, Gibbens et al. 1983, Herbel et al. 1972, Hennessy et al. 1983, Humphrey 1974, McLaughlin and Bowers 1982, McPherson 1995, Schlesinger et al. 1990). *Prosopis* spp. and other shrubs have extensive root systems that allow them to exploit deep soil water that is unavailable to shallower rooted

grasses and cacti (Burgess 1995). This strategy works well, except on sites that have well-developed argillic or calcic soil horizons that limit infiltration and storage of winter moisture in the deeper soil layers (McAuliffe 1995). McAuliffe (1995) found *Prosopis* spp. invasion on these sites to be limited to a few, small individuals. This has implications in plant geography and grassland revegetation work in the southwestern United States.

REFERENCES

Bourgeron and Engelking 1994, Buffington and Herbel 1965, Burgess 1995, Driscoll et al. 1984, Gardner 1950, Gibbens et al. 1983, Hennessy et al. 1983, Herbel et al. 1972, Humphrey 1974, McLaughlin and Bowers 1982, McAuliffe 1995, McPherson 1995, Nelson 1934, Schlesinger et al. 1990, Stein and Ludwig 1979

Bouteloua gracilis Herbaceous Vegetation

MAP CLASS	Blue Grama - Mountain Muhly Grassland Group
COMMON NAME	Blue Grama Herbaceous Vegetation
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V.)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (V.A.5.N.)
FORMATION	Short sod temperate or subpolar grassland (V.A.5.N.e.)
ALLIANCE	*Bouteloua gracilis* Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL Weak

USFS WETLAND SYSTEM Upland

RANGE

Walnut Canyon National Monument

Blue Grama Herbaceous Vegetation occurs mostly as small isolated patches throughout the project boundary in a mosaic with Ponderosa Pine (Pinyon Pine – Utah Juniper) / Blue Grama Woodland, Ponderosa Pine / Blue Grama Woodland, Pinyon-Utah Juniper / Blue Grama Woodland, Rabbitbrush / Blue Grama Herbaceous Vegetation, and Snakeweed / Modified Grassland Complex map classes. Only one relevé was assigned to this association and was identified from the northeastern section of the project boundary within an area of high disturbance.

Globally

This plant association occurs in Arizona, New Mexico and Wyoming.

ENVIRONMENTAL DESCRIPTION

Walnut Canyon National Monument

Only one relevé of this association was surveyed; it was at 6,759 ft (2,060 m) with a gentle slope (8%).

Globally

This plant association is reported from in Arizona, New Mexico and Wyoming. Elevation ranges from 6,000-7,200 ft (1,830-2,200 m). Sites are flat to gently sloping and include plains, plateaus and montane meadows. Substrates are variable and range from coarse-textured soils derived from sand, gravel or cinder to silty clay loam prairie soils.

MOST ABUNDANT SPECIES

Walnut Canyon National Monument

Stratum	Species
Herbaceous	*Bouteloua gracilis*

Globally

Stratum	Species
Herbaceous	*Bouteloua gracilis*

ASSOCIATED SPECIES

Walnut Canyon National Monument

Ericameria nauseosa, Hymenoxys richardsonii, Juniperus deppeana, Muhlenbergia montana, Pinus ponderosa (all occur with >1% cover)

Globally

Bouteloua curtipendula, Elymus elymoides, Muhlenbergia montana, Muhlenbergia richardsonis, Muhlenbergia torreyi, Pascopyrum smithii, Pleuraphis jamesii, Sporobolus cryptandrus, Bromus tectorum, Artemisia caruthii, Artemisia dracunculus

VEGETATION DESCRIPTION

Walnut Canyon National Monument

Blue Grama Herbaceous Vegetation total vegetation cover was 32%, with 11% absolute cover in the tree layer, 1% in the shrub layer, and 25% in the herbaceous layer. Only one relevé was sampled with total species diversity of 32 species.

The tree layer consisted of *Juniperus deppeana* (average DBH 9 in/22 cm) and *Pinus ponderosa* (average DBH 11 in/29 cm). The shrub layer was sparse. The herbaceous layer was dominated by *Bouteloua gracilis* with absolute cover of 20%.

Globally

This association is characterized by moderate to dense (25-80% cover) herbaceous layer that is strongely dominated by the warm season, perennial shortgrass, *Bouteloua gracilis*. Associated grasses are *Bouteloua curtipendula, Elymus elymoides, Muhlenbergia montana, M. richardsonis, M. torreyi, Pascopyrum smithii, Pleuraphis jamesii (= Hilaria jamesii), Sporobolus cryptandrus* and the introduced annual grass *Bromus tectorum.* Forb cover is sparse. Associated forb species include *Artemisia caruthii* and *Artemisia dracunculus.* Scattered *Ericameria nauseosa* shrubs and an occasional *Juniper* spp., *Pinus edulis,* or *P. ponderosa* (in montane stands) tree may be present.

CONSERVATION RANK G4Q

DATABASE CODE CEGL001760

MAP CLASSES

Blue Grama Herbaceous Vegetation is represented by Blue Grama - Mountain Muhly Grassland Group (map code 4).

Due to the inability to distinguish the differences in herbaceous species from aerial photography, the areas with high cover of *Bouteloua gracilis* (*Bouteloua gracilis* Herbaceous Vegetation) and *Muhlenbergia montana* (*Muhlenbergia montana* Herbaceous Vegetation) were combined into the Blue Grama - Mountain Muhly Grassland Group. Small patches of Blue Grama - Mountain Muhly Grassland Group were mapped throughout the project boundary. The total area of this group within Walnut Canyon NM is 10 ac (4 ha) within 12 polygons and the total area in the park environs is 217 ac (88 ha) within 72 polygons.

COMMENTS

Walnut Canyon National Monument

These small isolated patches of grassland may be relics of pre-settlement conditions where this grass occurred in large parks rather than isolated patches. These patches of grassland do not have high shrub cover and are hence a grassland rather than shrub herbaceous or steppe.

Globally

This is a low confidence association. There are many other associations in the *Bouteloua gracilis* Herbaceous Alliance (A.1282).

DYNAMICS

Globally

Bouteloua gracilis is an extremely drought- and grazing-tolerant shortgrass species. It is one of the most widely distributed grasses in the interior western U.S., and is present in many different grassland, shrubland and woodland communities. It evolved with grazing by large herbivores and generally forms a short sod. However, in some stands ungrazed plants develop the upright physiognomy of a bunchgrass.

REFERENCES

Bourgeron and Engelking 1994, Bradley et. al. 1992, Driscoll et. al. 1984, Dwyer and Peiper 1967, Fisser 1970, Fisser et. al. 1965, Hansen et. al. 2003, Madany and West 1980, Pieper 1968, Western Ecology Working Group of Nature Serve

Bromus (*tectorum, rubens*) Semi-natural Herbaceous Alliance

MAP CLASS	Snakeweed / Modified Grassland Complex
COMMON NAME	Cheatgrass Herbaceous Semi-natural Alliance
SYNONYM	Cheatgrass Annual Grassland
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Annual graminoid or forb vegetation (V.D.)
PHYSIOGNOMIC GROUP	Temperate or subpolar annual grasslands or forb vegetation (V.D.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (V.D.2.N.)
FORMATION	Short temperate annual grassland (V.D.2.N.d)
ALLIANCE	*Bromus tectorum* Semi-natural Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL Moderate

USFS WETLAND SYSTEM Upland

RANGE

Walnut Canyon National Monument

Cheatgrass Semi-Natural Herbaceous Vegetation occurs as a part of a complex of disturbed vegetation associations in the northeast section of the project boundary. This association was only identified from one relevé on disturbed USDA-FS lands in the northeastern section of the project environs. *Juniperus monosperma* was chained in this area to increase the forage potential of the site for grazing (USDA Forest Serve Rangelands 2004).

Globally

This alliance-level herbaceous vegetation type is found throughout much of western North America from the western Great Plains to intermountain and southwestern U.S.

ENVIRONMENTAL DESCRIPTION

Walnut Canyon National Monument

Only one relevé was surveyed of this association and it occurred at an elevation of 6,529 ft (1,990m) in a flat area.

Globally

This alliance-level herbaceous vegetation type is found throughout much of western North America from the western Great Plains to intermountain and southwestern U.S. Elevation ranges from sea level to 7,218 ft (2,200 m). Stands occur after disturbance of a natural shrub- or grass-dominated community resulting in the replacement of the natural vegetation by non-native, annual grass species of *Bromus*. At Wind Cave National Park in South Dakota, weedy non-native graminoid vegetation occurs on recently disturbed areas, most commonly along roads. Small stands also occur in prairie dog towns (H. Marriott pers. comm. 1999). In the Great Basin, *Bromus tectorum* grasslands has invaded large areas of burned-over sagebrush steppe. *Bromus tectorum* increases the fire frequency of steppe communities, which eventually eliminates sagebrush (FEIS 2001).

MOST ABUNDANT SPECIES

Walnut Canyon National Monument

Stratum	Species
Shrub	*Gutierrezia sarothrae*
Herbaceous	*Bromus tectorum, Bromus rubens*

Globally

Stratum	Species
Shrub	*Gutierrezia sarothrae*
Herbaceous	*Bromus tectorum, Bromus rubens*

ASSOCIATED SPECIES

Walnut Canyon National Monument

Amaranthus sp., *Convolvulus arvensis, Elymus elymoides, Erigeron divergens, Hymenoxys richardsonii, Linaria genistifolia, Packera multilobata, Sphaeralcea* sp. (all occur with >1% cover)

Globally

Bromus carinatus, Bromus hordeaceus, Bromus madritensis, Bromus japonicus, Bromus rigidus, Bromus rubens

VEGETATION DESCRIPTION

Walnut Canyon National Monument

Bromus (tectorum, rubens) Semi-natural Herbaceous Alliance total vegetation cover was 44% with 1% in the tree layer, 20% in the shrub layer, and 23% in the herbaceous layer. Only one relevé was sampled with total species diversity of 26.

The tree layer was sparse. The shrub layer was dominated by *Gutierrezia sarothrae* with absolute cover of 7%. The herbaceous layer was dominated by the invasive annual grasses *Bromus tectorum* and *Bromus rubens* with absolute cover of 12%.

Globally

This alliance-level vegetation type is characterized by a sparse to dense short annual graminoid layer that is typically dominated by *Bromus tectorum* with over 80-90% of the total vegetation cover. Other Eurasian introduced annual species of *Bromus* which may alternatively dominate or codominate are *Bromus carinatus, Bromus hordeaceus, Bromus madritensis, Bromus japonicus, Bromus rigidus,* or *Bromus rubens*. Although there may be remnant species of the former native vegetation, the high cover of annual bromes makes it difficult to determine what natural community was formerly present. At Wind Cave National Park in South Dakota, this weedy non-native graminoid vegetation is usually dominated by several perennial and annual brome grasses, including *Bromus inermis, Bromus japonicus,* and cheatgrass *Bromus tectorum*. Cover is variable (H. Marriott pers. comm. 1999).

CONSERVATION RANK GW

DATABASE CODE CEGL003019

MAP CLASSES

Cheatgrass Semi-Natural Herbaceous Vegetation is represented by map class Snakeweed / Modified Grassland Complex (map code 7).

Snakeweed / Modified Grassland Complex was mapped as part of a mosaic within the chained areas in the project environs, dominated by the exotic invasives *Bromus tectorum* and *Bromus rubens*. The following vegetation types were mapped as one class: *Gutierrezia sarothrae* Modified Dwarf-shrubland [provisional], *Bromus* (*tectorum, rubens*) Semi-natural Herbaceous Alliance, *Aristida purpurea* Herbaceous Vegetation, *Bouteloua eriopoda* Herbaceous Vegetation, and *Ericameria nauseosa – Gutierrezia sarothrae* Shrubland (local assemblage). The total area of this complex within Walnut Canyon NM is 101 ac (41 ha) within 10 polygons and the total area in the park environs is 2,417 ac (978 ha) within 28 polygons.

COMMENTS

Walnut Canyon National Monument

Disturbed alliances and associations have not been well defined in the NVCS; therefore, further study will allow for better classification of the alliances and associations.

Globally

This alliance also includes grasslands dominated or codominated by other Eurasian introduced annual *Bromus* species, but is distinct from the annual *Bromus* communities found along the Pacific Coast with Mediterranean or maritime climates because it does not have the introduced annual oatgrass (*Avena barbata* and *Avena fatua*), or other species typical of the California annual grassland (Sawyer and Keeler-Wolf 1995).

DYNAMICS

Globally

Bromus tectorum is an annual grass and is able to complete its lifecycle in the spring before drying out mid-summer. Its fine structure makes it extremely flammable when dry, and it will increase the fire frequency of a site (FEIS 2001). Frequent fires favor *Bromus tectorum* because they eliminate competing perennial vegetation, but do not kill all the *Bromus tectorum* seeds, which survive in the unburned organic material (FEIS 2001). This altered ecological process has promoted the spread of *Bromus tectorum* and other exotic annual bromes at the expense of sagebrush shrublands in large parts of the western U.S. (Daubenmire 1975, Young and Evans 1973, 1978).

This type is most common where disturbances have eliminated or largely set back the native vegetation. Where the brome grasses are invading native vegetation, the types may still be tracked as native types, since the native species may still persist. A recent study (Karl et al. 1999) found that despite strong seed and seedling production by the exotic brome grasses (*Bromus japonicus*, *Bromus tectorum*), the large amount of herbaceous biomass produced by the two vegetatively propagating native grasses, *Bouteloua gracilis* and *Pascopyrum smithii* suggests that these native grasses may well maintain their ecological importance in the stands.

In Nevada, Beatley (1976) found dense stands of the introduced winter annual grass *Bromus tectorum* growing in disturbed *Artemisia* shrublands. *Bromus rubens* is more common in lower elevation sites, and *Bromus tectorum* is most common in higher elevation sagebrush and pinyon-juniper communities.

REFERENCES

Beatley 1976, Daubenmire 1975, FEIS 2001, Karl et al. 1999, Sawyer and Keeler-Wolf 1995, Thompson 2001, Von Loh 2000, Young and Evans 1973, Young and Evans 1978

Muhlenbergia montana Herbaceous Vegetation

MAP CLASS	Blue Grama – Mountain Muhly Grassland Group
COMMON NAME	Mountain Muhly Herbaceous Vegetation
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V.)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (V.A.5.N.)
FORMATION	Medium-tall bunch temperate or subpolar grassland (V.A.5.N.d.)
ALLIANCE	*Muhlenbergia montana* Herbaceous Vegetation

CLASSIFICATION CONFIDENCE LEVEL Moderate

USFS WETLAND SYSTEM Upland

RANGE

Walnut Canyon National Monument

Mountain Muhly Herbaceous Vegetation occurs mostly as small isolated patches throughout the project boundary within Ponderosa Pine / Blue Grama Woodland map class. This association was found from our relevé data on USDA-FS and State Lands, specifically northwest of Walnut Canyon and near Anderson Mesa.

Globally

This plant association forms meadows in the mountains and foothills of Colorado, Arizona and Utah.

ENVIRONMENTAL DESCRIPTION

Walnut Canyon National Monument

Only two relevés were assigned to this alliance, with elevation ranging from 6,857-6,890 ft (2,090-2,100 m). Both relevés were recorded on moderate slopes of (11-14%).

Globally

This plant association has been described from meadows in the mountains, plateaus and foothills of Colorado, Arizona and Utah. Elevation ranges from 7,540-9,200 ft (2,300-2,800 m). Sites are typically xeric forest openings or parks in the Ponderosa Pine zone with southern aspects on moderately steep slopes and ridgetops. Occasionally the stands occupy rolling parklands or volcanic cinder fields. The xeric nature of sites appears to be an important environmental factor. Substrates are shallow to moderately deep, rocky, sand to sandy loam textured soils sometimes with a distinct clay horizon. Parent materials are primarily colluvium derived from granite and gneiss or cinder. Bare soil, exposed gravels, and small rocks account for as much as 50% of the ground surface area.

MOST ABUNDANT SPECIES

Walnut Canyon National Monument

Stratum	Species
Herbaceous	*Muhlenbergia montana*

Globally

Stratum	Species
Herbaceous	*Muhlenbergia montana*

ASSOCIATED SPECIES

Walnut Canyon National Monument

Bouteloua gracilis, Eriogonum racemosum, Festuca arizonica, Heterotheca villosa, Juniperus osteosperma, Lupinus sp., *Pinus ponderosa, Quercus gambelii, Robinia neomexicana* (all occur with >1% cover)

Globally

Allium geyeri, Antennaria rosea, Arenaria fendleri, Artemisia frigida, Blepharoneuron tricholepis, Bouteloua curtipendula, Bouteloua gracilis, Carex duriuscula, Danthonia parryi, Elymus albicans, Eriogonum

umbellatum,Festuca brachyphylla, Harbouria trachypleura, Hesperostipa comata, Heterotheca villosa, Koeleria macrantha, Mertensia lanceolata,Muhlenbergia filiculmis, Opuntia polyacantha, Pascopyrum smithii, Penstemon secundiflorus, Phlox diffusa, Poa secunda, Schizachyrium scoparium, Trisetum spicatum

VEGETATION DESCRIPTION

Walnut Canyon National Monument

Only two relevés were assigned to the Mountain Muhly Herbaceous Vegetation with total vegetation cover of 42 and 48%, with 9 and 17% absolute cover in the tree layer, 2 and 7% absolute cover in the shrub layer, and 25 and 32% absolute cover in the herbaceous layer. The species diversity in the two relevés was 25 and 26 species.

In both relevés the tree layer consisted of a sparse *Pinus ponderosa* cover (4 and 9% absolute cover) and DBH ranged from 6-11 in (14-29 cm) (average 9 in/24 cm). The shrub layer was sparse and not dominated by a single species. *Muhlenbergia montana* was the dominant herbaceous species with 12 and 22% absolute cover. *Bouteloua gracilis* occurred in both relevés with generally lower cover (5-14%) than *Muhlenbergia montana*.

Globally

This association is characterized by a moderately dense herbaceous layer that is typically dominated by the warm-season, perennial bunchgrass *Muhlenbergia montana*, but may be codominated by *Blepharoneuron tricholepis* or *Trisetum spicatum (= Trisetum montanum)* (in New Mexico). Other associated graminoids include *Bouteloua curtipendula, Bouteloua gracilis, Carex duriuscula (= Carex eleocharis), Danthonia parryi, Elymus albicans (= Elymus lanceolatus* ssp. *albicans), Festuca brachyphylla, Hesperostipa comata, Koeleria macrantha, Muhlenbergia filiculmis, Pascopyrum smithii, Poa secunda*, and *Schizachyrium scoparium*. The typically sparse forb layer often consists of *Allium geyeri, Antennaria rosea, Arenaria fendleri, Eriogonum umbellatum, Harbouria trachypleura, Heterotheca villosa, Mertensia lanceolata, Opuntia polyacantha, Penstemon secundiflorus* and *Phlox diffusa.* Except for the abundant dwarf-shrub *Artemisia frigida*, scattered *Ericameria nauseosa* shrub or occasional *Pinus ponderosa* trees, woody species are very sparse or absent. Occasional *Pinus ponderosa* trees may be present. The exotic grasses *Poa pratensis* and *Bromus tectorum* are common in some of these stands. Diagnostic of this grassland association is the dominance of *Muhlenbergia montana* in the herbaceous layer and low cover of *Festuca arizonica*.

CONSERVATION RANK G3G4

DATABASE CODE CEGL001646

MAP CLASSES

Mountain Muhly Herbaceous Vegetation is represented by map class Blue Grama - Mountain Muhly Grassland Group (map code 4).

Due to the inability to distinguish the differences in herbaceous species from aerial photography, *Bouteloua gracilis* Herbaceous Vegetation and *Muhlenbergia montana* Herbaceous Vegetation were combined into the map class Blue Grama - Mountain Muhly Grassland Group. The total area of this group within Walnut Canyon NM is 10 ac (4 ha) within 12 polygons and the total area in the park environs is 217 ac (88 ha) within 72 polygons.

COMMENTS

Walnut Canyon National Monument

These small isolated patches of grassland may be relics of pre-settlement conditions where this grass occurred in large parks rather than isolated patches. These patches of grassland do not have high shrub cover and are hence a grassland rather than shrub herbaceous or steppe.

Although both Mountain Muhly Herbaceous Vegetation and Blue Grama Herbaceous Vegetation have a co-dominance of *Bouteloua gracilis* and *Muhlenbergia montana, Muhlenbergia montana* takes precedence in these mixed community types. If *Bouteloua gracilis* has higher cover than *Muhlenbergia montana* then this association is classified as Blue Grama Herbaceous Vegetation; however, if *Muhlenbergia montana* has equal or higher cover than *Bouteloua gracilis* than the vegetation is classified as Mountain Muhly Herbaceous Vegetation.

DYNAMICS

Globally

Muhlenbergia montana often grows in association with montane conifer forests, especially ones dominated by *Pinus ponderosa* and has developed a tolerance for relatively frequent fire regimes. Although *Muhlenbergia montana* resprouts after burning, it may take a few years to recover to pre-burn density (Fischer and Bradley 1987) These grasslands may be considered seral or an edaphic climax depending if there are environmental factors, such as aridity, that are preventing establishment of trees. Historically, much of the area where this association occurs was heavily grazed by livestock, primarily sheep and cattle (Shepherd 1975). Season of use is important in stands with both *Hesperostipa comata* and *Muhlenbergia montana*; fall grazing will favor *Hesperostipa comata* over the later blooming *Muhlenbergia montana* (Clary 1978). The reverse is true if grazing is always limited to summer. Overgrazing will reduce or eliminate *Hesperostipa comata*, *Muhlenbergia montana* and the other palatable species, leaving the more grazing-tolerant *Bouteloua gracilis* and less palatable plants such as *Hymenoxys*, *Artemisia* and *Chrysothamnus* species to dominate the site Clary (1978).

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Pascopyrum smithii Herbaceous Vegetation

MAP CLASS	Introduced Western Wheatgrass Grassland
COMMON NAME	Western Wheatgrass Herbaceous Vegetation
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V.)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (V.A.5.N.)
FORMATION	Medium-tall sod temperate or subpolar grassland (V.A.5.N.c.)
ALLIANCE	*Pascopyrum smithii* Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL Weak

USFS WETLAND SYSTEM Upland

Walnut Canyon National Monument
This association was only described during the photointerpretation process. No field data was collected on the specifics of this vegetation type.

CONSERVATION RANK G3G5Q

DATABASE CODE CEGL001577

MAP CLASSES
This map class was mapped as occurring in small linear polygons in the northeastern section of the project area, inside or adjacent to the map class Snakeweed / Modified Grassland Complex. The total area of this group within Walnut Canyon NM is 1 ac (0.4 ha) within 1 polygon and the total area in the park environs is 15 ac (6 ha) within 11 polygons.

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